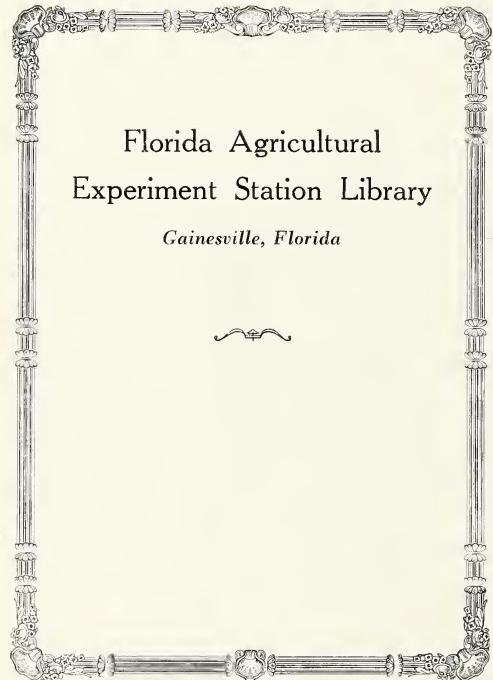


**HOW TO CONTROL
PLANT DISEASES**

MALCOLM C. SHURTLEFF

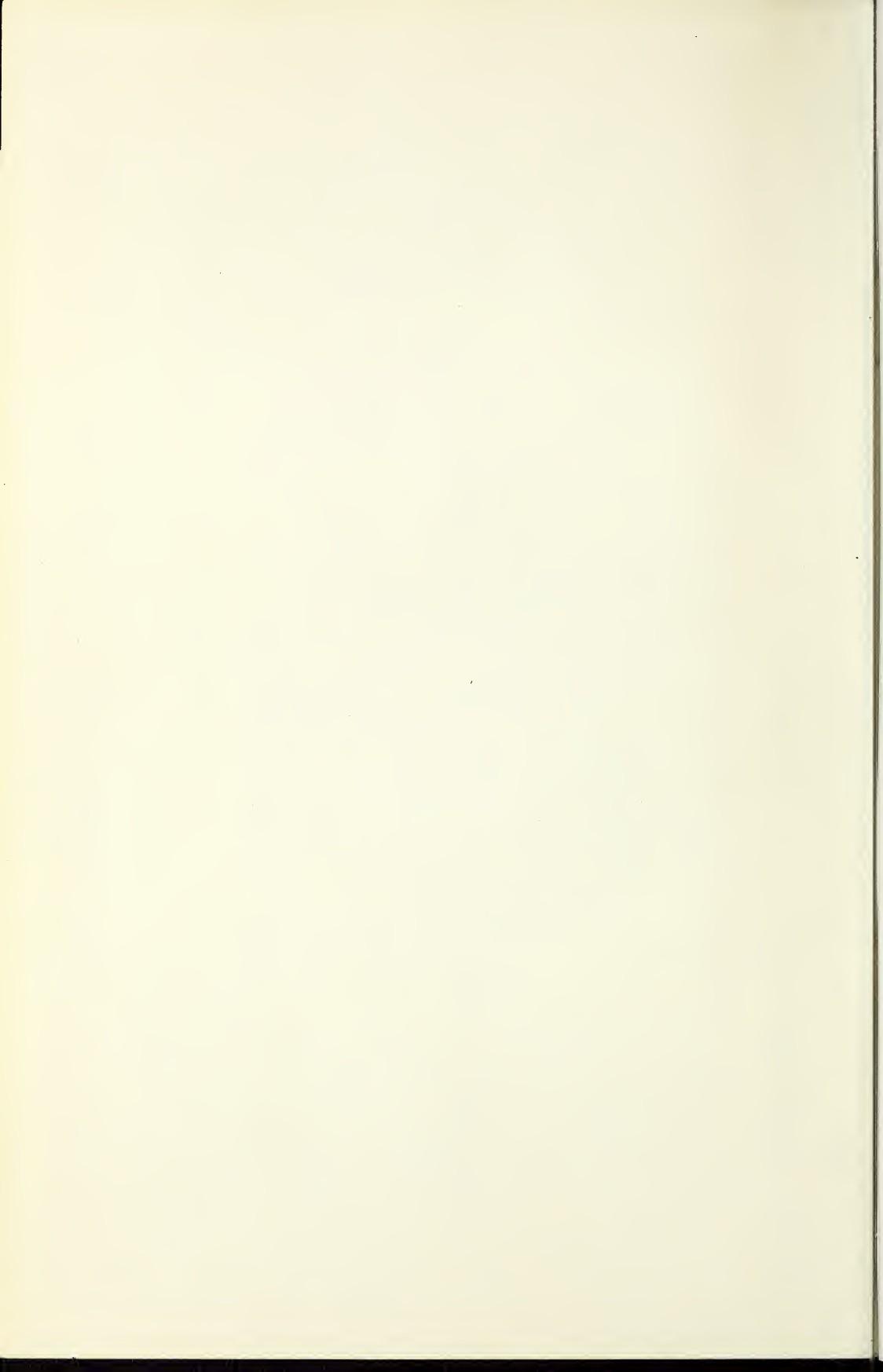


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**How To Control
PLANT DISEASES
in Home and Garden**



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HOW TO CONTROL PLANT DISEASES in Home and Garden

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Art Work by
ROGER D. ALBERTSON



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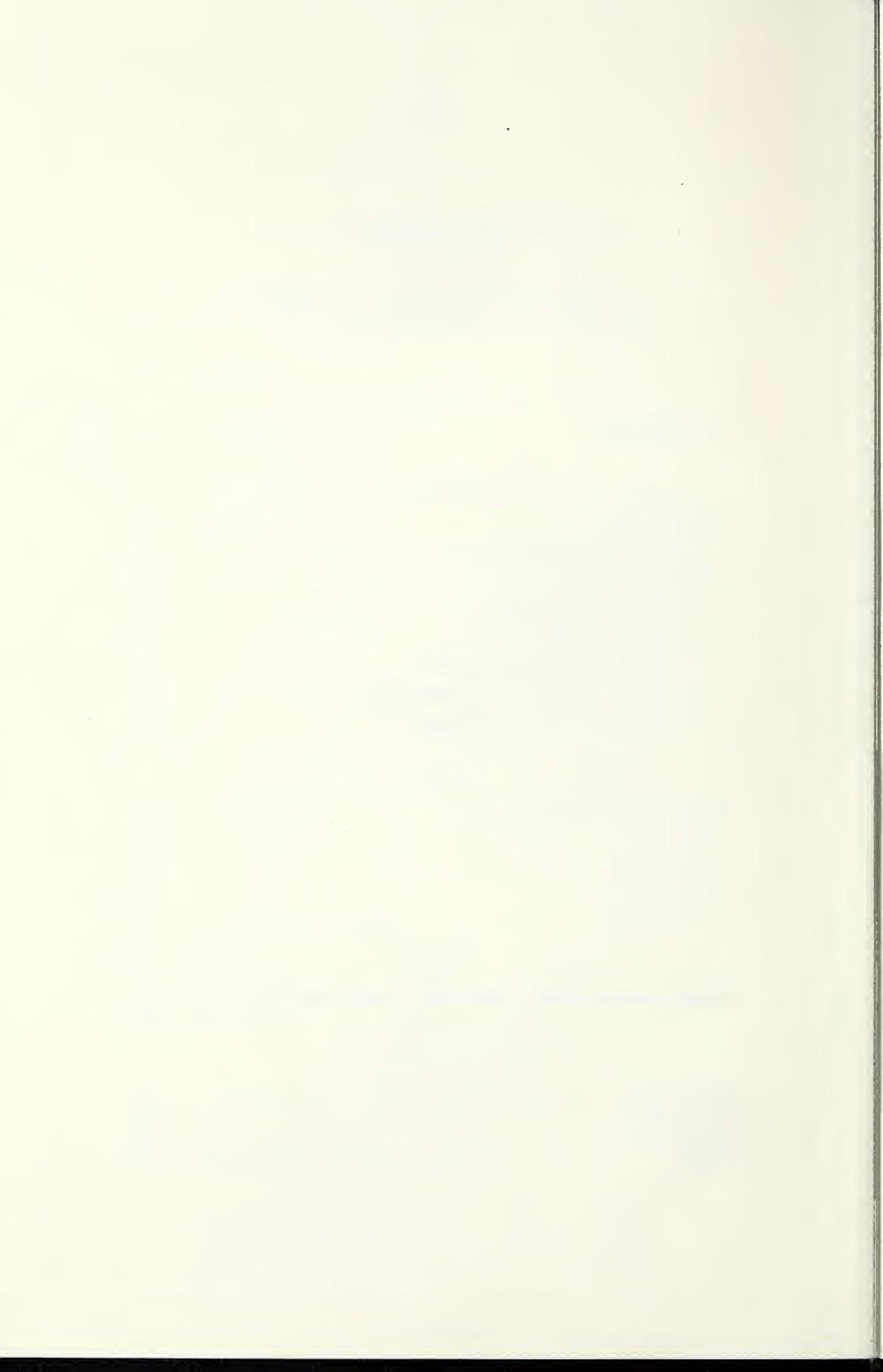
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CONTENTS

See detailed Table of Contents at beginning of each section

	Color Code	Page
Section 1		
INTRODUCTION	(Brown)	1
Section 2		
"WHAT IS IT?"	(Red)	13
Environmental Factors	.	14
General Diseases	.	33
A. Foliage Diseases	.	33
B. Stem Diseases	.	62
C. Flower and Fruit Diseases	.	70
D. Root and Bulb (Corm) Diseases	.	73
E. Parasitic Flowering Plants	.	78
Section 3		
"WHAT CAN I DO ABOUT IT?"	(Green)	81
Measures	.	82
Materials	.	84
Equipment	.	92
Section 4		
HOME AND GARDEN PLANTS AND THEIR DISEASES	.	107
Other Useful Information		
APPENDIX	.	417
GLOSSARY	.	447
INDEX	.	463



A NOTE TO THE READER

ALL LIVING PLANTS grown in and around the home, yard, and garden are subject to attack by disease-producing organisms and agents. Plant diseases — the despair of gardeners the world over — should be considered as much a part of nature as sun, wind, rain, weeds, and insects.

This book is intended to acquaint gardeners — amateur and professional alike, as well as the many people who advise them — with the numerous types of disease problems that flowers, vines, trees, shrubs, lawngrasses, vegetables, and fruit may contract. The cultural and chemical practices necessary to keep them in check are outlined. Naturally a book of this size cannot exhaust the subject of more than 50,000 diseases. But it does describe the diseases — common and uncommon — of more than 810 genera of home and garden plants grown in the United States and Canada. Ailments of the same plant which look much alike have often been lumped together. Closely related plants which are damaged by the same general group of diseases, like those in the cabbage, cucumber, and carnation families, are also placed together. Since all plants are listed by both common and scientific names, you as a reader and user should have little difficulty finding what you are looking for.

To cover as much material as possible in a brief space, the style is terse and pointed. The material has been organized into sections which are coded with different colors. Each section has its own index. Each is a unit by itself and should answer such questions as "What is it?" "What can I do about it?" and "How serious is it?"

Do not expect this book to be a panacea for all your garden ills. Occasionally diseases are found which can be easily confused with other diseases, soil deficiencies, insects, or mechanical injury. In cases like this, check over the disease descriptions given under the specific plant in Section 4 and under the disease in Section 2. Think back over the past history of the plant and the area of the yard or garden where it is growing. Still no answer? Now it's time to call in a specialist for his evaluation. Don't be afraid to talk over your problem with a successful grower, your local nurseryman, florist, or the people at the garden supply center. Ask them for their advice. There is also the local county extension office or extension specialist at your land-grant college or university whom you can call on for assistance.

No attempt has been made to include insect injuries except in a few instances when the effects of such injuries lead to definite disease-like conditions. Where insects are important in transmitting disease-producing organisms and agents, control measures are suggested.

Intentionally, I have avoided use of scientific names for the causal pathogens and agents. Common names generally suffice and are much more meaningful to all (except a handful of biologists) than is *Colletotrichum lindemuthianum*, *Gymnosporangium juniperi-virginiana*, or *Belonolaimus longicaudatus*. Besides, common names usually lend stability to nomenclature. The scientific names of many bacteria, viruses, and nematodes, particularly, are in a state of flux.

Use this book as a handy reference when you're in trouble. Or, better still, *before* you're in trouble. And remember that even the best gardeners occasionally have disease problems.

Before plunging in, read the "How to use this book" section. From then on we hope it will be clear sailing.

ACKNOWLEDGMENTS

No book containing the condensate from the research findings of thousands of plant scientists can possibly be the work of one person. I am greatly indebted to the following: George Rose and Marshall Townsend helped with organization and general layout; Betty Rinderknecht gave the text short, punchy sentences and provided preliminary editorial help; Ray Fassel was a genial and painstaking editor; the great majority of the illustrations were done by a brilliant young artist, Roger D. Albertson; Mrs. Betty Lartius contributed five sketches in Section 1; photographs were kindly provided by friends and by chemical or equipment manufacturers with credit for these being given in the legends to the figures; John L. Weihing, Charles H. Sherwood and Don C. Norton were kind enough to read the entire manuscript in an early stage and contributed many valuable comments and criticisms; A. E. Cott, James C. Horton, John P. Mahlstede, Harold S. McNabb, Jr., Lawrence I. Miller, Ben F. Vance, and Donald B. White critically read certain parts of the manuscript; Mrs. Connie Betten and my wife, Margaret, assisted in the typing. My wife also had the task of taking care of our three children while the manuscript was being prepared and later typed. This book could not have been written without the generous assistance of these people.

In making these acknowledgments, I wish to make it clear that those who have assisted are absolved from any responsibility for errors or mistakes I have committed, in spite of their efforts.

MALCOLM C. SHURTLEFF

January, 1962

SECTION 1

Introduction

How to use this book	1	What is a plant disease?	6
Where you can get additional help	3	Classification of diseases	6
Land-grant institutions and agricultural experiment stations in the United States	4	Causes of plant diseases	7
How to send in plant specimens	5	Unfavorable growing conditions	7
Extent of plant diseases	6	Bacteria	8
		Fungi	9
		Viruses	10
		Nematodes	11

HOW TO USE THIS BOOK

This book is written primarily for the home gardener. It also should prove a useful reference for the commercial vegetable grower, orchardist, berry grower, nurseryman, turf specialist, student or extension specialist in the plant sciences, county agricultural agent, vocational agriculture teacher, specialist for commercial concerns or state departments of agriculture, garden writer, and others who know and love plants.

The attempt has been to write in easy-to-understand language, omitting as much technical terminology (e.g., scientific names of disease-causing organisms, mycological or pathological terms) as practical. An extensive glossary (pages 447-61) explains the technical terms used in the text.

Two questions people invariably ask about a plant disease are, "What is it?" and "What should I do about it?" Sometimes such questions as "How serious is

it?" or "Will it kill my plants?" follow. This book answers these four basic questions.

The answer to "What is it?" or disease diagnosis is based on plant responses which are expressed as symptoms. These result from some disease-inducing factor. The most general types of diseases, based on external and internal symptoms, are given in Section 2 (red pages). The listings of *Plants Attacked* in this section come largely from USDA Handbook No. 165, *Index of Plant Diseases in the United States*, and the second edition of Cynthia Westcott's *Plant Disease Handbook* published by the D. Van Nostrand Company, Inc.

Section 3, "What Can I Do About It?" (green pages) covers the essential points in control which govern most plant diseases. Usually several types of control measures are needed to protect against, check, or eradicate an infection. The

amount of disease control is dependent upon the timeliness, completeness, and type of control measures used.

Cross references are made to general types of diseases pictured and described in Section 2, and to control measures outlined in Section 3, listed under individual plants, or given in the Appendix.

The information found in Section 4 (pages 107-415) includes those trees, shrubs, vines, house plants, flowers, fruit, vegetables, and lawnglasses likely to be grown in and around the home, yard, and garden in any geographical area of the United States. Certain native plants sometimes grown in wild gardens are listed as well as forest trees which are sometimes used as ornamentals. Strictly field crops have been omitted.

The plants are listed alphabetically from Aaronsbeard to Zygotelatum under both common and scientific names. The important diseases are listed under each plant. To reduce bulkiness, plants have been put together which have similar disease problems. Where practical, all members of a plant family are placed under one or several plants in that family.

For example, plants related to carnation, e.g., garden pinks, sweet-william, babysbreath, Maltese cross, catchfly, and others in the family Caryophyllaceae having economic value are put together under carnation (see example below), probably the best known member of the family. Plants listed with carnation are cross-indexed under both common (Maltese cross) and scientific (*Lychnis*) names and refer you to carnation.

Where several species or horticultural types of a genus are widely grown, e.g., cottage, grass, maiden, and rainbow garden pinks, these are listed alphabetically within brackets after *GARDEN PINKS* (see below). Members of a plant family are listed alphabetically by the scientific name of the genus after the first common name (*CARNATION*). *Agrostemma* comes before *Arenaria* with the remaining genera *Gypsophila*, *Lychnis*, *Plumaris*, and *Silene* following.

Example:

CARNATION [FLORIST'S, HARDY], *GARDEN PINKS* [COTTAGE, GRASS, MAIDEN, RAINBOW], SWEET-WILLIAM (*Dianthus*); CORNCOCKLE

(*Agrostemma*); SANDWORT (*Arenaria*); BABYSBREATH (*Gypsophila*); EVENING CAMPION, MULLEIN-PINK, MALTESE CROSS, RED and ROSE CAMPION, JERUSALEM-CROSS, ROSE-OF-HEAVEN (*Lychnis*); HARDY GRASS PINK (*Plumaris*); CUSHION-PINK, FIRE-PINK, STARRY and MOSS CAMPION, CATCHFLY [ALPINE, SWEET-WILLIAM] (*Silene*)

Where a disease infects certain plants in a listing and not others, the plants attacked are listed in parentheses after the name of the disease. Following the carnation example above we find on pages 169 that *Fusarium* Wilts infect carnation, pinks, and sweet-william; *Bacterial* and *Verticillium* Wilts attack only carnation; while *Alternaria* Leaf Spot and Branch Rot infect carnation, Maltese cross, pinks, and sweet-william.

The diseases listed in this book are those reported from the continental United States. Diseases peculiar to Hawaii, Alaska, Puerto Rico, the Virgin Islands, and the Canal Zone are omitted principally for lack of space. Many of the diseases are found more or less generally throughout the world.

The geographic range, in nature or in cultivation, of the various diseases should be taken only as a rough guide. Diseases listed as "General" are usually coextensive with the plant host; "Widespread" means that the disease is reported from many scattered locations in the United States but is not prevalent; "Frequent" and "Occasional" denote intensity as well as range of occurrence.

Certain regional designations (e.g., eastern, southern, or southeastern states; Pacific Coast, Midwest) are also used to denote specific geographical areas where certain diseases are prevalent or have been reported.

If appropriate, the prevalence of the disease, the potential destructiveness of the ailment, and the weather conditions which favor or check disease development are mentioned. This should answer the questions "How serious is it?" and "Will it kill my plant?"

The information you seek should be easy to find, especially with the use of the extensive index.

The Appendix (pages 417-46) contains

average spray programs for common fruits and seed and soil treatments with methods, materials, and precautions. Also included are conversion tables for measuring dry and liquid chemicals, useful units of measure, methods for converting Fahrenheit to Centigrade and vice versa, measurements and rates of application equivalents, a pesticide compatibility chart, and an operating chart for tractor boom sprayers.

To illustrate, let us take a plant disease and find all we can regarding it. To make the case specific, suppose the apple tree in the back yard that for so long has granted shade and fruit in season, this year has alarming spots on its leaves, and, as the fruit matures, spots which are somewhat similar to those on the leaves appear on the fruit as well. A neighbor spoke of various apple diseases to you at the time you purchased the tree and you vaguely remember his mentioning that a disease that sounded like skob or scab might produce the symptoms that are evident.

So you begin in Section 2 looking un-

der disease (14) Scab. After reading the introductory material about it, you come to the material on control and observe that a spray program is suggested. Section 4 presents plants in alphabetical order, so looking through the A's you come to apple. Here disease 2 is Scab and controls are mentioned under it.

On the other hand, it is possible that you only know that it is a disease of apple since it is on your apple tree. In that case, you would immediately turn to the information on apples in Section 4 and start comparing your diseased specimen with the explanations and illustrations presented there for identification of the disease. Once the evidence indicates that the disease is scab, you will turn back to Section 2 and read the material there on scab as well as reading that in Section 4 and also turn to Section 5, the Appendix, to check the apple spray program. From this point on, it is only necessary to follow the directions and observe the suggestions given in the various parts of the book to which you are directed.

WHERE YOU CAN GET ADDITIONAL HELP

You can get help on diagnosis and control of plant problems by contacting your county agricultural agent (sometimes called farm advisor, county agent, or county extension director) or by writing your state land-grant college or university. A listing of these institutions is below. Write to your extension plant pathologist concerning diseases, the extension entomologist for information about insects, or to the extension horticulturist regarding cultural problems.

All states publish free pest control

recommendations. Each state department of agriculture along with the USDA have a wide variety of printed matter on plant pest control which is available through your county extension office or land-grant institution.

There are local authorities or plant experts in your community who would be only too happy to talk with you about your disease problems. These people include your florist, nurseryman, garden supply dealer, commercial fruit and vegetable growers, and turf specialist.

LAND-GRANT INSTITUTIONS AND AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES

All states have at least one Extension Horticulturist to answer questions on cultural management of garden plants. States listed below with one asterisk (*) have an Extension Entomologist (insects, mites, rodents) and states with two asterisks (**) also have an Extension Plant Pathologist (diseases). Write to the specialist in care of the College of Agriculture at your state land-grant institution.

For free bulletins, circulars, pamphlets, spray schedules, etc., write to the Bulletin Room, College of Agriculture, at your state university or college.

- * Alabama: Alabama Polytechnic Institute, Auburn.
- ** Alaska: University of Alaska, College (or Experiment Station, Palmer).
- ** Arizona: University of Arizona, Tucson.
- ** Arkansas: University of Arkansas, Fayetteville (or Cooperative Extension Service, 1201 McAlmont Ave., Little Rock).
- ** California: University of California, Berkeley 4; Agricultural Extension Building, Riverside, or Davis.
- * Connecticut: University of Connecticut, Storrs (or Connecticut Agricultural Experiment Station, New Haven 4).
- ** Delaware: University of Delaware, Newark.
- ** Florida: University of Florida, Gainesville.
- * Georgia: University of Georgia, Athens [or Agricultural Experiment Station (State), Experiment; Coastal Plain Station, Tifton].
- Hawaii: University of Hawaii, Honolulu 14.
- ** Idaho: University of Idaho, Extension Service, Boise; Agricultural Experiment Station, Moscow.
- ** Illinois: University of Illinois, Urbana.

- ** Indiana: Purdue University, Lafayette.
- * Iowa: Iowa State University, Ames.
- ** Kansas: Kansas State University, Manhattan.
- Kentucky: University of Kentucky, Lexington 29.
- * Louisiana: Louisiana State University, University Station, Baton Rouge 3.
- Maine: University of Maine, Orono.
- ** Maryland: University of Maryland, College Park.
- ** Massachusetts: University of Massachusetts, Amherst.
- ** Michigan: Michigan State University, East Lansing.
- ** Minnesota: Institute of Agriculture, University of Minnesota, St. Paul 1.
- * Mississippi: Mississippi State University, State College.
- * Missouri: University of Missouri, Columbia.
- ** Montana: Montana State College, Bozeman.
- ** Nebraska: College of Agriculture, University of Nebraska, Lincoln (or Scott's Bluff Experiment Station, Mitchell).
- * Nevada: University of Nevada, Reno.
- New Hampshire: University of New Hampshire, Durham.
- ** New Jersey: State College of Agriculture, Rutgers University, New Brunswick.
- * New Mexico: New Mexico State University, University Park.
- ** New York: New York State College of Agriculture, Cornell University, Ithaca (or Agricultural Experiment Station, Geneva; Ornamentals Research Laboratory, Farmingdale).
- ** North Carolina: North Carolina State College, State College Station, Raleigh (or A&T. College, P.O. Box 1014, Greensboro).

- * North Dakota: North Dakota State University, State College Station, Fargo.
- ** Ohio: The Ohio State University, Columbus 10 (or Agricultural Experiment Station, Wooster).
- ** Oklahoma: Oklahoma State University, Stillwater.
- ** Oregon: Oregon State University, Corvallis.
- ** Pennsylvania: The Pennsylvania State University, University Park.
- Puerto Rico: University of Puerto Rico, Rio Piedras.
- ** Rhode Island: University of Rhode Island, Kingston.
- ** South Carolina: Clemson Agricultural College, Clemson.
- * South Dakota: South Dakota State College, Brookings.
- ** Tennessee: University of Tennessee, Knoxville 16.
- ** Texas: Texas A&M. College, College Station (or Box 476, Weslaco; Tyler Experiment Station No. 2, R. 6, Tyler; Agricultural Building, Texas Tech., Lubbock).
- * Utah: Utah State University, Logan.
- * Vermont: University of Vermont, Burlington.
- Virgin Islands: Virgin Islands Agric. Project, Kingshill, St. Croix (officer in charge).
- ** Virginia: Virginia Polytechnic Institute, Blacksburg [or Virginia Truck Experiment Station (truck crops), Norfolk 1; Piedmont Fruit Research Laboratory, Charlottesville; Winchester Fruit Research Laboratory, Winchester].
- ** Washington: Washington State University, Pullman (or Western Washington Experiment Station, Puyallup).
- ** West Virginia: West Virginia University, Morgantown.
- ** Wisconsin: University of Wisconsin, Madison 7 (or Peninsular Branch Experiment Station, Sturgeon Bay).
- ** Wyoming: University of Wyoming, Laramie.

HOW TO SEND IN PLANT SPECIMENS

To help in diagnosing plant pests (diseases, insects, or weeds), wrap fresh plant specimens, showing a range of symptoms, in cellophane, plastic bags, wax paper, or aluminum foil. Do not send fleshy fruit in advanced stages of decay. Seal the wrapper tightly and mail in a crush-proof carton or mailing tube. Do not add moisture. Enclose or attach a letter giving as much history as possible. This should include the date collected, variety and kind

of plant attacked, prevalence of the pest, degree of severity, description of the pest, part diseased or injured, extent of garden area involved, cropping history when known, weather and soil conditions, recent fertilization, watering, pest control measures, etc. Don't forget your return address! Remember that correct diagnosis is essential before control measures can be suggested. A diagnosis can only be as good as the specimen you send!

EXTENT OF PLANT DISEASES

All garden plants are attacked at one time or another by disease. There are over 80,000 different diseases. In addition several hundred species of parasitic nematodes also injure plants.

The annual loss in the United States from plant diseases and nematodes is about \$4 billion. This loss means higher grocery bills plus increased costs for clothing and shelter for all of us. Did you know, for example, that diseases cause more loss to our nation's forests each year than does fire?

Plant diseases are a normal part of nature and can be considered as one of the many environmental factors that help keep each of the many thousands of living organisms in balance with each other in undisturbed nature. When man selects and cultivates plants he must recognize

that diseases will have to be considered as one of the many expected hazards.

Plant diseases are not new. They undoubtedly arose and developed as life arose and developed on earth. The Bible mentions many injurious pests including rusts, mildew, and blast. These diseases and others have plagued man and caused famines since the dawn of recorded history. Fossils have been found which suggest that plants had disease enemies long before man even appeared on earth.

This book is not designed to scare you about the thousands of diseases you will never see in a garden. It is to enable you to know and recognize the occasional disease which may require prompt action. The pictures and disease descriptions should help you become familiar with the most common ones.

WHAT IS A PLANT DISEASE?

When a plant is continuously affected by some factor which interferes with its normal structure or activities, it is said to be diseased. Injury, in contrast, results from a momentary damage. Broad-

ly speaking, a plant is considered diseased when it does not develop or produce normally, considering the conditions of its growth. Often there is no sharp distinction between healthy and diseased plants.

CLASSIFICATION OF DISEASES

A sick plant may not be as different from a sick human or animal as you think. For instance, increases in temperature and rate of respiration may occur when plants become infected.

Plant ailments, like those of humans or animals, are often classified by their effects or visible symptoms. Humans have fevers and plants have wilts. People suffer from colds, sore backs, an unbalanced diet, or measles while plants are weakened with spots, blights, rots, mildews, cankers and rusts, or an unfertile, compacted soil.

Many plant diseases, however, which appear alike by external symptoms may be caused by widely different micro-organ-

isms or agents and require completely different methods of control. This is where a careful laboratory diagnosis by a trained plant doctor comes in handy. It is obvious that the causal organism, agent, or environmental factor be known positively before proper control measures can be initiated.

In Section 2 "What is it?", we have classified plant diseases by symptoms divided up conveniently into those which affect the foliage; stems, twigs, branches, or trunk; the flowers and fruits; or the roots and other underground parts.

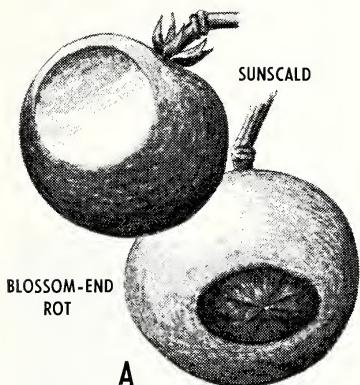
Plant diseases may also be grouped according to their causes.

CAUSES OF PLANT DISEASES

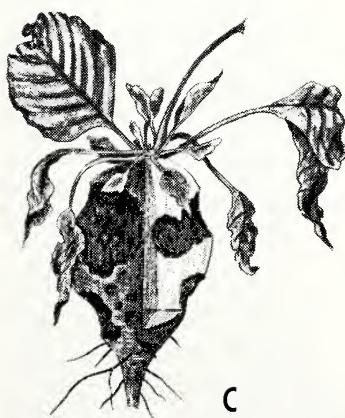
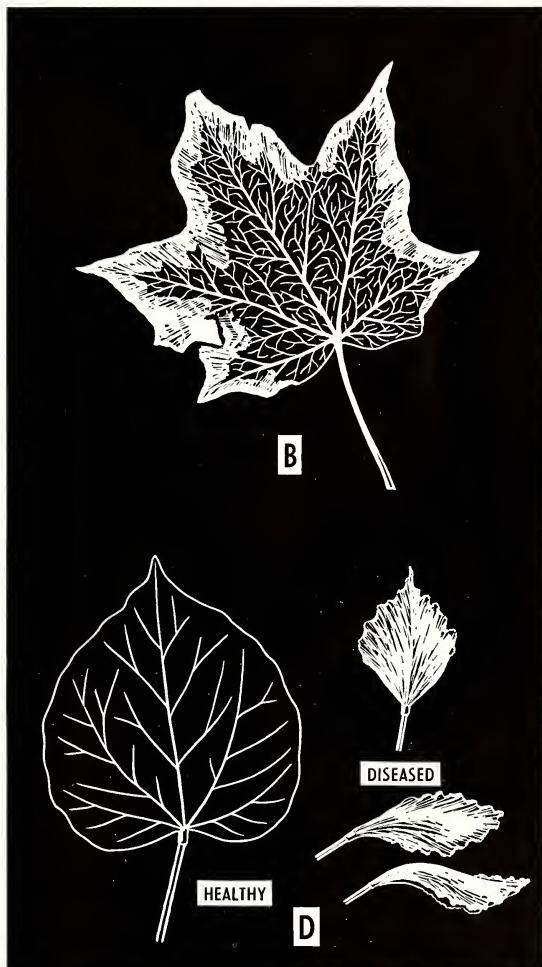
The causes of plant diseases may conveniently be divided into two groups: those caused by unfavorable growing conditions (nonparasitic) and those caused by a parasite (bacteria, fungi, viruses,

nematodes, and parasitic flowering plants).

Unfavorable growing conditions. Non-parasitic or noninfectious diseases include those caused by excesses or deficiencies of light, air humidity, water, or essential



A



C

Fig. 1. Nonparasitic diseases. A. Sunscald and blossom-end rot of tomato, B. Leaf scorch of maple, C. Boron deficiency of beet, D. 2,4-D injury to redbud leaves.

soil nutrients (e.g., nitrogen, phosphorus, potassium, calcium, iron, magnesium, manganese, boron, copper, molybdenum, zinc, sulfur, etc.), soil moisture-oxygen disturbances, extreme acidity or alkalinity in the growing medium, pesticide injury, extremely high or low temperatures, injurious impurities in the air or soil, soil grade changes, girdling tree roots, mechanical and electrical agents, plus unfavorable preharvest and storage conditions for fruits, vegetables, bulbs, etc. Plants in poor health from unfavorable growing conditions outnumber those caused by disease-producing organisms.

This book doesn't attempt to cover in detail the wide range of nonparasitic ailments which affect garden plants. We simply suggest you follow the best cultural practices for each of your garden plants as given in state and federal garden bulletins, nursery and seed catalogs, books and magazines. This would include information on varieties to plant, planting depth, shade or sun, type of soil, fertilization programs, water require-

ments, winter or summer protection, pruning, insect control, weed control, and other practices. Some general information on plant culture in relation to plant diseases is given in Section 2. Additional help may be obtained by talking with experienced and reliable garden supply dealers, nurserymen, florists, arborists, or fellow gardeners in your community. Garden clubs and plant societies also offer a means of exchanging helpful gardening hints.

Several of the more common nonparasitic diseases are shown in Figure 1.

Parasites. The diseases we shall concern ourselves with primarily are those caused by microorganisms (bacteria, fungi, and nematodes) and viruses. These are infectious diseases which often spread easily from diseased to healthy plants.

Bacteria. Bacteria are minute, one-celled plants (although recent staining techniques have shown that the bacterial body may actually be composed of 2 to 4 cells) which lack chlorophyll and hence cannot make their own food.

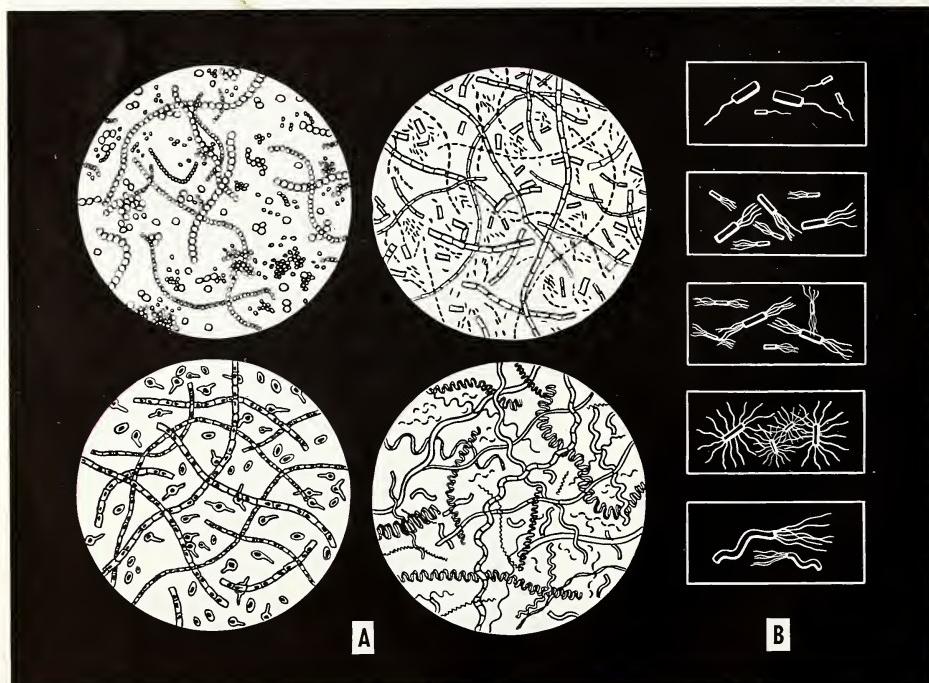


Fig. 2. Bacteria. A. Different forms as you might see them under a powerful laboratory microscope, B. Bacteria showing various types of flagella.

Placed end to end it would take about 20,000 bacteria to make an inch. Twenty trillion bacteria may weigh only an ounce. Yet the top foot of soil in 1,000 square feet of your garden contains about 20 pounds of bacteria! A cubic foot of garden soil weighs an average of 85 to 90 pounds.

Bacteria multiply simply by dividing in half every 20 minutes to an hour or more when conditions are favorable. If a single bacterium divided in half and, if all of its descendants did likewise every hour for a day, there would be nearly 17,000,000 bacteria after just 24 hours. Is it any wonder that bacteria cause iris, calla, vegetables, and fruits to sometimes rot so quickly?

Bacteria enter plants through wounds and small natural openings that occur over the surface of plants. Once bacteria are inside a plant they multiply rapidly, break down tissue, and often migrate throughout the plant. Many types swim about in water or in plant sap by means of whipping one or more "tails" called flagella (Figure 2) or by a rhythmic pulsation of the bacterial body.

Bacteria are spread by man through cultivating, pruning, and transporting diseased plant material. Animals, insects, splashing rain, flowing water, and wind-blown dust are also common disseminating agents.

Several hundred types of bacteria cause plant disease. The most common types of disease caused by bacteria are soft rots, leaf spots or blotches, blights, stem rots or cankers, wilts, and galls.

Bacteria, the simplest of plants, overwinter (or oversummer) on or inside perennial or winter annual plants, seeds, plant refuse, garden tools, or in soil. A few may even live for several months or longer in the bodies of living insects.

Fortunately most disease-causing bacteria are quickly killed by high temperatures, dry conditions and strong sunlight. Many bacteria in the soil, capable of causing plant disease, are inhibited by antibiotic substances secreted by other soil-inhabiting organisms (chiefly bacteria and fungi).

Fungi. Fungi, like bacteria, are also simple plants which lack chlorophyll. They obtain their food from living plants and animals or from decaying, nonliving, organic material. Together with bacteria,

fungi break down organic matter into nutrients which can be utilized by garden plants. If it were not for fungi and bacteria, our world would probably be piled many feet deep with dead plant and animal remains.

The top foot of soil in 1,000 square feet of garden contains about 30 pounds of fungi.

A typical fungus usually starts life as a microscopic spore which can be compared to the seed of a higher plant. Under moist conditions the spore may germinate and produce one or more branched threads called hyphae. The hyphae grow and divide to form fungus bodies called mycelia. Hyphae may penetrate a plant by growing into a wound, through a natural opening, or by forcing their way directly through a plant's protective "skin" or epidermis (see Figure 3).

The fungus body composed of an interwoven mass of hyphae usually gives rise to spores or spore-bearing bodies, completing the life cycle. The life cycle of certain fungi (e.g., rusts) are extremely complex and may involve a number of different spore stages and more than one plant host. See (8) Rust, under General Diseases in the next section.

Most fungi are rather inconspicuous but certain molds, mildews, and mushrooms are known to almost everyone. Some have fruiting bodies which are two feet in diameter and weigh up to fifty pounds or more! Some of the large puff-balls contain billions of spores.

Spores come in many different shapes, sizes, and colors (see Figure 3). Perhaps "average" fungus spores when laid end to end would total 2,500 to an inch.

Spores play an important part in the multiplication, dissemination, and survival of fungi. Spores are easily carried by wind, water, insects, man, animals, plant parts (e.g., seeds, bulbs, etc.), and equipment.

Certain fungus spores have been known to blow a thousand miles or more, sometimes at high altitudes, before descending (frequently in a rainstorm) and infecting plants.

Resting spores often allow the fungus to withstand unfavorable growing conditions such as extreme heat, cold, drying, and flooding. Spores of certain fungi may lie dormant for a number of years. When

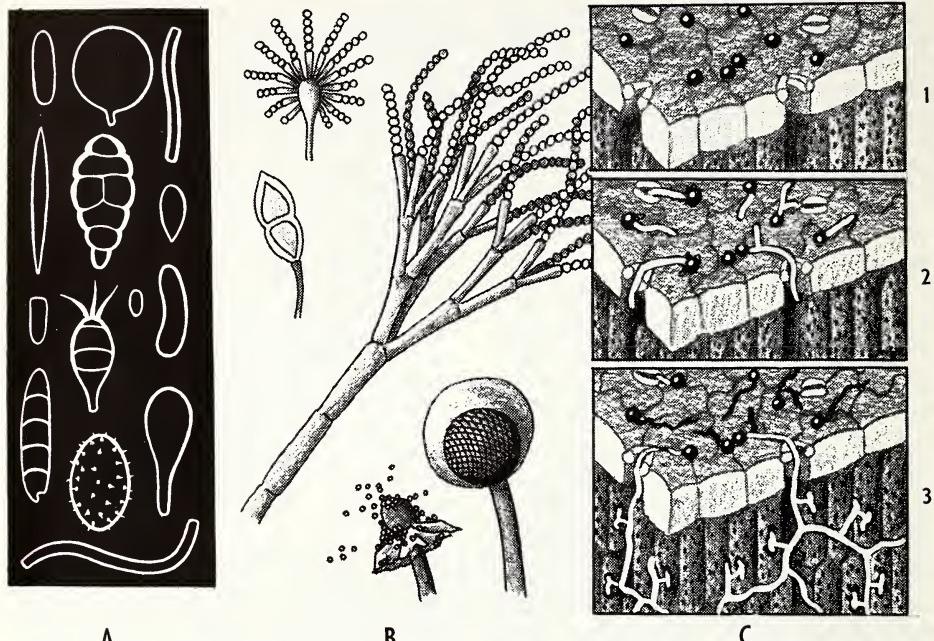


Fig. 3. Fungi. A. Various spore forms visible with a microscope, B. Different structures on which fungus spores are borne, C. Successive stages in germination of spores (1), followed by penetration into a leaf (2) through stomates, and establishment of infection (3). Fungus spores usually need a film of moisture on the surface of a leaf in order to germinate and penetrate plant tissue.

they persist in the soil, they are very difficult to kill.

Certain fungi do not produce spores. They multiply by forming compact masses of hyphae called sclerotia or by the fungus body dividing up into fragments which are broken off and spread by water, wind, man, and other agents.

Bacteria and fungi are more prevalent and damaging to plants in damp areas or seasons than in dry ones. Moisture is usually essential to their rapid reproduction, spread, penetration of plant parts, and infection of plant parts.

Fungi cause the majority of infectious or parasitic plant diseases. They include all rusts, smuts, mildews, and scabs; many leaf spots, cankers, and blights; root, stem, and fruit rots; wilts; leaf galls; and others.

Many parasitic fungi alternately live on dead and living plant tissues; others, like those causing the rusts and mildews, exist only on living plants. Fungi, like bacteria, overwinter on and in plant refuse,

soil, perennial plants, and seed or occasionally in insects. Most fungus spores and hyphae are easily killed by adverse conditions. Knowledge of these habits guides the development of effective control measures.

Viruses. Viruses are complex protein molecules which infect, multiply, mutate, and otherwise act like living organisms when in living plant or animal tissue. They are much smaller than bacteria (perhaps 250,000 or more to an inch) and cannot be seen with the ordinary laboratory microscope.

A number of viruses have been crystallized in the laboratory. Yet they multiply only in the presence of living cells at the expense of normal proteins required by the plant. Hence viruses usually lead to abnormal growth expressed in various ways.

The most common types of virus-caused diseases are mosaics, yellows, curly-top, spotted wilt, ringspots, stunt, and phloem

necrosis of elm. Many crop plants and weeds may harbor viruses but show no external symptoms, especially in hot weather. Certain variegated plants (e.g., Abutilon, Rembrandt tulips) are inherently virus-infected.

Viruses express symptoms which are often greatly variable even on different varieties of the same plant (e.g., stone fruits). Viruses are consequently often grouped together generally by symptoms, regardless of true virus relationships. Symptoms of virus diseases pertain only to viruses with visible symptoms.

Some plant viruses are quite infectious, being spread easily from diseased to healthy plants by mere contact. Others are transmitted in nature only by the feeding and plant-to-plant movement of insects (primarily aphids, leafhoppers, and thrips). Practically all can be spread by propagating (e.g., grafting, budding, cuttings) virus-infected planting stock, and a very few by infected seed, pollen, soil, mites, nematodes, or possibly other minute animal life in the soil.

Viruses often overwinter in perennial crops and weeds, in the bodies of insects, and in plant debris.

Virus-caused diseases are receiving more attention by research workers now than formerly. This is partly due to a better understanding of viruses and to an apparent increase in the number of new, virus-caused diseases. How new viruses originate is not fully known.

Nematodes. Nematodes that attack plants are slender, microscopic round-worms (often called nemas or eelworms). The majority cannot be seen with the naked eye, rarely exceeding 1/20 of an inch long (see Figure 4). Nematodes are common in water, decaying organic matter, all moist garden soils, and tissues of other living organisms. Most types are harmless, feeding upon decomposing organic material and other soil organisms. A few are even beneficial to man since they are parasitic on plant-feeding types or other pests.

In order to grow and reproduce, parasitic nematodes usually require living plants from which they suck plant juices, reduce vigor and afford easy entrance for wilt- or rot-producing fungi and bacteria. Nematode-damaged plants may also be more susceptible to winter injury.

Nematodes may live part of the time

(sometimes in the winter) free in soil around roots or in fallow fields and gardens. Parasitic nemas tunnel inside plant tissues or feed externally from the plant surface, especially the roots (Figure 4). Nemas may enter plants through wounds, natural openings, or by penetrating the delicate roots and pushing in between the cells.

Nematodes usually reproduce by laying eggs. These hatch, sometimes after months or even years, releasing young, wormlike

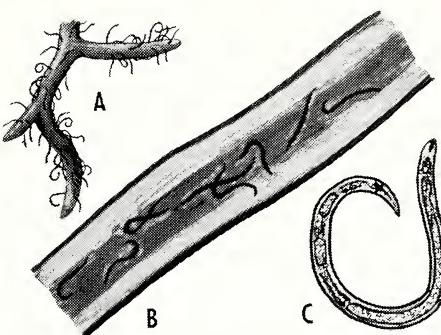


Fig. 4. Nematodes. A. Nematodes feeding on surface of roots, B. Nematodes feeding inside a root, C. Nematode greatly enlarged showing internal structure.

nematodes (larvae) which are usually born ready to start feeding. Nematodes multiply much faster than higher animals, but much more slowly than bacteria and fungi.

Most parasitic species require three weeks or longer to complete a generation from egg through several larval stages to adult and back to egg again. Some nematodes have only one generation a year. But the offspring in this one generation may number many hundreds.

After a plant parasitic nema has been accidentally introduced into fields or gardens, it usually requires several years or longer before sufficient numbers (many millions of active nematodes per acre) are present to cause conspicuous disease symptoms in a large number of plants. This is because nematodes move very slowly through the soil under their own power — rarely more than thirty inches a year.

Nematodes, however, are easily spread about by any agency involving moist, infested soil or plant parts. These include

all types of garden equipment and machinery, running water, shoes, feet of animals, and movement of infested planting stock especially with soil around the roots.

Only a few garden-infesting species cause typical plant disease symptoms. These include the root-knot nematode, leaf, bud, stem, and bulb nematodes, and possibly a few others. See Figures 36, 50, and 51.

The best known nematode, the root-knot nematode, causes galls on plant roots. It is known to attack over 2,000 kinds of plants. Most root-feeding species, however, cause no specific symptoms. Infested plants often look as if they were suffering from drought, excessive soil moisture, malnutrition, or a disease (e.g., wilt, dieback, crown rot, or root rot).

Many times the first indication of nematode injury in a garden or field is the appearance of circular or irregular areas of stunted, sickly plants. These spots are small in the beginning and gradually enlarge. Plants in the center may gradually die. The roots are often stunted, stubby, and discolored.

It has been conservatively estimated by USDA nematologists that nemas get at

least one-tenth of everything the farmer grows! Much of this loss could be avoided.

It is necessary to examine the roots of unthrifty or abnormal plants, and also the surrounding soil for known parasitic types. This can be done only by a trained nematologist working in a well-equipped laboratory. If you suspect nematode injury, contact your local county extension office for information regarding collection of samples for identification of parasitic types.

Certain nematodes live strictly in light, sandy soils. Some build up high populations in muck soils; others seem to thrive best in heavy soils.

Many species of nemas are easily killed by air-drying the soil while other types remain alive but in a dormant state. When dormant they are much more difficult to kill by chemicals (nematocides; see Table 14 in the Appendix) or heat than when they are moist and actively wiggling. Crop rotation is often an important control measure. Because complete control is impossible or unlikely, periodic checks are most desirable whenever troublesome types have been found in large numbers.

SECTION 2

“What Is It?”

ENVIRONMENTAL FACTORS	14
1. Planting	14
2. Soil	15
3. Adding Organic Matter	16
4. Loosening Hard Soil	16
5. Loose Soil Surface	16
6. Soil pH	16
7. Soil Test	17
8. Nutrient Deficiencies	17
9. Fertilizing Plants	18
10. Pruning	20
A. Shrubs	21
B. Trees	21
11. Tree Removal	22
12. Treatment of Wounds	22
13. Staking Trees and Shrubs	25
14. Soil Drainage	25
15. Watering	27
16. Light	27
17. Oedema	28
18. Air Humidity	28
19. Temperature	28
20. Scorch or Sunscorch	28
21. Winter Injury	28
22. Chemical Injuries	29
23. Mechanical Injuries	30
Construction Damage	30
Changing the Soil Grade	30
24. Electrical Injuries	32
25. Check and Double Check	32
26. Here We Go	32
GENERAL DISEASES	33
A. Foliage Diseases	33
(1) Fungus Leaf Spot	33
(2) Bacterial Leaf Spot or Blight, Bud Rot	33
(3) Leaf Blight, Leaf Blotch, Anthracnose, Needle Blight, or Cast of Evergreens	35
(4) Shot-hole	37
(5) Botrytis Blight, Gray-mold Blight, Bud Rot, Blossom Blight, Twig Blight	37
(6) Downy Mildew	39
(7) Powdery Mildew	41
(8) Rust — Leaf, Stem, Needle	43
(9) White-Rust, White Blister	47
(10) Leaf Curl or Gall, Leaf Blister, Witches'-broom, Plum Pockets	47
(11) Smut — Leaf, Stem, Anther, and Seed	47
(12) Sooty Mold or Blotch, Black Mildew	48
(13) White Smut, Leaf Smut	50
(14) Scab	50
(15) Wilts	50
A. Fusarium Wilt or Yellows	51
B. Verticillium Wilt	53
C. Bacterial Wilt, Brown Rot, or Blight	55
(16) Mosaic, Mottle, Crinkle, Streak, Calico, Virus Leaf Curl, Infectious Variegation, Flower Breaking	55
(17) Spotted Wilt, Ringspot	57
(18) Yellows, Aster Yellows, Rosette, Dwarf, Stunt	58
(19) Curly-Top, Western Yellow Blight	60
(20) Leaf, Bud, Stem, and Leaf Gall Nematodes	60

B. Stem Diseases	62	C. Flower and Fruit Diseases	70
(21) Crown, Foot, Stem, Stalk, Collar, or Rhizome Rot; Stem Blight, Southern Blight, Damping-off	62	(31) Flower or Blossom Blight, Ray or Inflorescence Blight	70
(22) Stem, Twig, Branch, or Trunk Canker; Dieback; Stem, Cane, or Limb Blight	63	(32) Fruit Spot, Speck, Rot, or Blotch; Seed, Berry, or Tuber Rot; Storage Rot	70
(23) Wood, Butt, Wound, Heart, or Sapwood Rot	64	(33) Smut	73
(24) Fire Blight, Bacterial Shoot Blight, Bacterial Canker, Gummosis . .	66	D. Root and Bulb (Corm) Diseases	73
(25) Black Knot	66	(34) Root Rot, "Decline," Cutting Rot	73
(26) Rust	66	(35) Clubroot	73
(27) Smut	66	(36) Bulb (Corm) or Rhizome Rot	75
(28) Leafy Gall, Fasciation, Witches'-broom	66	(37) Root-knot, Root Gall, Cyst Nematode	75
(29) Bacterial Soft Rot, Bacterial Stem Rot, Collar Rot	67	(38) Bulb Nematode, Ring Disease, Onion Bloat .	77
(30) Crown Gall, Cane Gall, Hairy Root, Bacterial Root Gall	68	E. Parasitic Flowering Plants	78
		(39) Mistletoes	78
		(40) Dodder, Strangle Weed, Love Vine, Gold Thread	80

Accurate disease diagnosis is essential to curing the plant. It is much like detective work, for first you must find out all the facts and then put the facts together like pieces in a jigsaw puzzle to make your case and reach a logical decision.

Let's take the sad case of Brother Juniper's wilting aster plants. Is it because a wilt-producing fungus or bacterium has invaded the water-conducting tissues? Is it a root rot? Has a stem canker or rot shut off the supply of water to the foliage? How about the possibility of borers or root-feeding insects? Is the soil too dry, too compact and hard? Is soil drainage poor? Any one of these factors could cause the wilting. But which one? By careful observation of the plants, close checking of each factor, and with experience, you have an excellent chance of reaching the right conclusion.

Before discussing the general types of infectious diseases, let's briefly review some of the problems common to the culture of garden plants. These may either cause nonparasitic ailments or lead to infection by microorganisms.

A complete discussion on the proper culture of plants would in itself constitute a volume of this size. In view of this, the discussion will be limited to difficulties

which result from improper culture and which resemble plant diseases. For a good discussion on the culture of garden plants read a book such as *The Care and Feeding of Garden Plants* published by the American Society for Horticultural Science and National Plant Food Institute, Washington, D.C.

ENVIRONMENTAL FACTORS

1. Planting

Plants may wither and die or become sickly (leaves change color, often drop early) because planting instructions were not followed. Death usually occurs during the first year.

Never allow the roots of plants to dry. On digging or receiving plants from a nursery, give the roots a good soaking and keep them damp until ready for planting. Keep them out of wind and away from heat. Whenever possible, prepare the planting holes in advance.

For balled and burlapped evergreens, dig the hole about a foot wider and deeper than the ball. Be sure to handle by the soil ball only, since handling the plants may cause the ball to break or roots to pull loose from the ball of soil. Set the evergreen at the same depth it was in the nursery. If the soil is poor, ex-

Brother Juniper

"Funny, you
don't look a
bit like your
pictures!"

(Courtesy
Publishers
Syndicate)



cavate and prepare a good soil mix composed of rich topsoil, sand, and peatmoss or compost. Fill the hole $\frac{2}{3}$ full, water thoroughly, cut the twine and peel back the burlap. Fill and pack firmly.

For bare-root plants, dig the hole large enough to prevent crowding and twisting of roots. Loosen the subsoil. Put a 4-inch mound of topsoil in the bottom of the hole and spread roots in a natural position over it. Sever the roots which are broken and bruised. Set the plant at the same depth it grew in the nursery row. Work a crumbly, rich topsoil mixture, composed of $\frac{1}{3}$ peatmoss or compost, among the roots by hand as the hole is filled with soil. Fill the hole gradually. Soak the hole thoroughly when about $\frac{1}{2}$ full. Then settle the plant firmly by shaking gently. This assures contact of roots with soil and prevents air pockets. Pack the soil firmly. Leave a rim of soil at the edge to form a water-holding basin.

Water deeply once a week (if less than $\frac{1}{2}$ inch of rain has fallen per week during the growing season) for the first two years.

Shrubs next to the home should be planted at a distance of a little less than one-half the spread of a mature shrub. Don't crowd plants. Plant shrubs outside the eave line or overhang on a ranch-style home, especially on the north and east sides of the building.

When soil is poor around the foundation, the entire bed should be dug out to a depth of $1\frac{1}{2}$ to 2 feet and replaced with good soil.

2. Soil

Soil is probably the most important factor in the success or failure of growing adapted or hardy plants. Healthy plants need a vigorous root system, ample soil nutrients (more correctly called elements or raw materials) and a porous

soil containing the proper mixture of clay, sand, silt and humus or organic matter. Any soil can be improved!

A good soil mixture for most house plants is made up of about 1 part each of good garden loam soil, organic matter (leafmold, well-rotted manure or compost, peatmoss), and coarse sand. Ferns, gardenias and azaleas require soils with a higher content of organic matter, while cacti and many other succulents do best in a very sandy soil low in organic matter. Other special soil mixtures may be desirable for certain plants, but they are the exceptions.

3. Adding Organic Matter

The addition of more organic matter will aid most garden soils. Mix in well-decomposed compost, peatmoss, or fresh barnyard manure. A compost pile (composed of layers of vegetable matter, animal manure, topsoil, and commercial fertilizer) in a back corner of the yard is an excellent investment. Check with your extension horticulturist on how to prepare a compost pile. If you have the land available, a green manure crop (e.g., ryegrass, soybeans, cowpeas, crimson clover, a cereal, buckwheat, or Sudan grass) sowed in the spring and plowed under in late summer makes excellent organic matter. In all but the most northern states you can sow rye or winter wheat in late summer and plow it under in the spring. Fertilization before plowing under hastens decomposition of the green manure. This is often desirable. Sandy or heavy clay soils are especially benefited by adding organic matter.

4. Loosening Hard Soil

Hard, compact soil can be loosened by incorporating compost, wood shavings, weed-free straw, peatmoss, buckwheat or cottonseed hulls, grass clippings, leaves, chopped corn fodder and fresh manure with straw bedding. When the added material is low in nitrogen (e.g., wood shavings and straw), apply a nitrogen-containing fertilizer to prevent crop injury.

5. Loose Soil Surface

Plants do best with a loose soil surface. This can be supplied by cultivation or, better still, by a surface mulch of organic material (see above). The condition of your soil will be improved by mixing organic matter with it.

6. Soil pH

Is your soil acid or alkaline? This can be easily tested with an inexpensive soil test kit. Or you can take a composite soil sample and have it tested at your county extension office. The proper test will show the soil to be alkaline, neutral, slightly acid, or acid. Perhaps your test will be returned showing numbers on a pH scale. A pH of 7 is considered neutral. A pH of 6 to 6.5 is slightly acid, and a pH of 4.5 to 5.5 indicates the soil is acid or sour. Below pH 4 and above 9 most plants have a hard time growing. Soils in the United States range in pH from about 3.6 for certain acid peat soils to 9.5 for some black alkali soils. The favorable pH range for most crop and garden plants is 6.2 to 7.5.

The great bulk of garden plants are not particular as to soil reaction (pH) and will grow under a wide range of conditions. Exceptions are blueberry, dewberry, huckleberry, hydrangea, andromeda, camellia, some ferns, orchids and lilies, azalea, mountain-laurel, rhododendron, holly, white cedar, fir, fuchsia, gardenia, gloxinia, heath, hemlock, ixora, juniper, larch, leucothoë, lily-of-the-valley, crapemyrtle, arbutus, scotch broom, magnolia, pine, spruce, tamarack, weeping willow, yew and a few others. The foliage of these plants may turn yellow (chlorotic or chlorosis) because of a lack of available iron or other elements which may be due to excessive lime. These plants are best grown in an acid soil with a pH of 4.2 to 5.5 or 6.0. Soil can be acidified by adding aluminum sulfate, equal parts of powdered sulfur and iron sulfate, pine needles, or acid peatmoss (e.g., German peat or Michigan reed peat) to the soil. Aluminum sulfate, if overdosed, is toxic to plants. Use it with caution. The addition of $\frac{3}{4}$ pound of sulfur per 100 square feet of garden increases the acidity of average soil about one pH point. Check with your extension horticulturist, county agent or nurseryman regarding acidifying soil. Replacing the soil about the roots with an acid soil may be preferable to acidifying the old soil.

Liming is necessary in some areas to make the soil less acid. Avoid overliming. Too much lime can be as harmful to plant growth as too little lime. A good rule to follow is "lime by test—not by guess." Lime, when needed, is spread on

the soil and then worked into the top 6 inches or so of topsoil. Finely ground dolomite limestone containing calcium and magnesium is the preferred form of lime in areas needing magnesium. Hydrated lime, finely ground oyster shells, and marl may also be used.

In the alkaline soils of large areas of the Midwest and arid parts of the United States many types of plants suffer from "iron chlorosis" unless the soil is acidified or iron-containing salts are placed in the soil root zone, injected into plants, or sprayed on the foliage. Chlorosis may also be caused by a deficiency of calcium, zinc, manganese, sulfur, viruses, and other parasites. Excessive applications of lime may also induce iron, manganese, and zinc deficiencies.

7. Soil Test

If you suspect soil or fertilizer problems, contact your county extension office for advice. Frequently a soil test will be suggested to determine what, if any, fertilizers or other treatments are advisable. County agents and their assistants know the soils in your area and what types of soil problems are most likely to occur. Only by a soil test can you be reasonably sure of what nutrients or other special care your soil needs. You can often save money by testing soil, since one or more nutrients may not be needed. Plants, like humans, differ in their individual nutrient needs. Plants in different stages of maturity also vary greatly in their tolerance to soil problems. Because soil tests are not infallible, certain plants may often respond to fertilization although the unfertilized soil has sufficient nutrients for "less particular" plants. Different varieties of the same plant may even react differently in the same soil!

Special forms and mailing tubes are available at your county extension office for you to have your soil tested, usually for a nominal fee.

8. Nutrient Deficiencies

Plants growing in unfertile soil often appear sickly and weak. Abnormal foliage color may be due to a deficiency of one or more soil nutrients. Although more than 50 elements are used by plants, only the more important nutrient deficiencies are discussed in this book. For additional information, contact your extension horticulturist or plant pathologist. Good, well-

illustrated books on the subject include *Hunger Signs in Crops*, published by the American Society of Agronomy and the National Fertilizer Association and *The Care and Feeding of Garden Plants*, published by the American Society for Horticultural Science and the National Plant Food Institute.

Stunted plants with small, pale green leaves, fading to yellow, often indicate a *nitrogen* deficiency. Plants are often spindly and weak. Nitrogen deficiency is probably the most common "hunger" sign in plants. Correct by applying a nitrogen-containing fertilizer, use legumes in the rotation, grow green-manure crops, or spray with nitrogen materials. Check with your county agent or extension horticulturist.

A superabundance of nitrogen may cause stunting, chlorosis, lack of fruit and flower development, and bud drop of rose, sweetpea, tomato, and other plants.

Phosphorus-deficient plants usually have dark green leaves, followed by bronzing, reddening, or purpling, especially along the veins. Later, the leaves may develop purplish blotches. Plants and fruit are often stunted, mature late, and have shrunken seeds. Control by applying a complete commercial fertilizer or add separately as superphosphate.

Potassium deficiency often is evident as a curling, scorching, browning, or bronzing of the leaf margins and tip. Older leaves are usually the first affected. Stems are weak and roots are underdeveloped. Plants are often stunted and appear "rusty." Correct by applying a complete fertilizer containing about 5 to 10 percent potash.

Iron, manganese, and zinc deficiencies frequently cause yellowing of the tissues between the veins on the youngest leaves (chlorosis). See Figure 79. Later the entire leaf may become yellow, then cream-colored to white, and finally brown or scorched. Plants are often stunted. If severe, the foliage and growing tips may die. Control is by acidifying the soil, applying foliage sprays containing the sulfate form of iron, zinc, or manganese, or by the use of chelates of iron, manganese, or zinc as sprays, trunk injections or as ground applications. See under the plant involved.

A lack of *boron* often causes plants to be stunted and brittle with a scorching of

the tips and margins of younger leaves. Older leaves are malformed and distorted while edible shoots, roots, and fruits are corky and discolored. Twig tips may die back. Symptoms are most severe in dry areas or seasons and in alkaline soils. In some areas boron is excessive, and crop injury to boron toxicity is not uncommon. Excess boron may cause plants to be stunted and yellowed or die prematurely. Germination may be delayed or prevented altogether. For additional information, read the USDA Information Bulletin No. 211, *Boron Injury to Plants*.

Magnesium deficiency symptoms usually appear on the older and lower leaves as a gradual fading of the normal green color at the margins, tips, and between the veins. Later these areas turn yellow (pink or red on some plants) and finally brown. When severe, the lower leaves die and may drop prematurely. The yellowing of the leaves progresses upward until only the tip leaves appear normal. In corn, or other plants with parallel veins, the yellowing appears as stripes. Control by using dolomitic limestone, magnesium-containing fertilizers or Epsom salts (magnesium sulfate).

Molybdenum deficiency causes Whiptail of cauliflower and broccoli (see under cabbage). The leaves on other thin-leaved plants may be stunted, curled upward, pale or yellow in color, and malformed. The margins of older leaves die (red in beets) with symptoms progressing upward to the younger leaves. Plants vary greatly in their requirement for molybdenum.

Plants also require *copper* in minute amounts. Lack of copper (principally in muck or peat soils of Florida and California) causes leaves to be darker green or even appear to have a bluish tint. Leaf edges curl upward and the green color gradually fades until it borders just the principal veins. Beginning with the lowest leaves, the pale areas in affected leaves gradually turn brown and die. Twigs may die back. Plants are stunted, and flowering is either delayed or checked altogether. Carrots are poorly colored and bitter. A deficiency of copper is easily checked by applying copper sprays to control disease or by applying copper sulfate to the soil.

A *calcium* deficiency causes the flower stem of gladiolus and tulip to topple. Roots of many plants are short and

stubby. Twig tips may die back. Correct by spraying the growing plants with calcium nitrate or add ground limestone, dolomite or gypsum to the soil.

Deficiency symptoms will not appear if the soil contains an ample, balanced supply of available plant food, and the soil pH is favorable for growing plants.

Starving plants, like starving animals or people, make poor growth and may become more susceptible to attack by certain disease organisms. The causes of poor growth are often complex and frequently cannot be traced back to a lack of or excess of some plant nutrient. Freezing temperatures, hot dry winds, drought, mechanical injury, insects or diseases, presence of nearby tree roots, too much sun or shade, poor soil drainage, etc., sometimes produce effects that are comparable to nutrient deficiencies.

9. Fertilizing Plants

Use fertilizer carefully and as directed. Careful use can reduce maintenance and pruning requirements of shrubs. Don't overfeed. Excessive fertilizer applications may cause serious injury. Late summer applications of fertilizer encourage tender growth in the fall which usually leads to severe winter injury.

Growth is usually stimulated by an application of fertilizer, provided there is ample moisture in the soil. Well-maintained and vigorous plants are also more resistant to disease and insect damage. The wounds of well-fertilized trees and shrubs also heal more quickly.

Commercial fertilizers should always have a label which gives an analysis like 10-10-10, 6-10-4, or 5-10-5. The first figure denotes the percentage of nitrogen (N), the second, phosphorus (P) — actually phosphoric acid (P_2O_5), and the third, potassium (K) — actually potash (K_2O).

The rate and methods of application of commercial fertilizers vary considerably with the individual needs of the plants involved and the purpose of the application.

The time to fertilize garden plants depends on their characteristics.

When preparing the lawn, vegetable, or flower seedbed, broadcast 1 to 4 pounds of a complete commercial fertilizer per 100 square feet. More may be needed on light, easily leached soils. Work the fertilizer into the top 4 to 6 inches or more of soil.

For established lawns spread the ferti-

lizer on the grass surface with a carefully calibrated lawn spreader and water it in immediately.

For vegetables, flowers, small fruits, and other crops the fertilizer is frequently placed in a band or bands below or near the seeds or plants at the time of planting. The fertilizer is sometimes placed about 2 inches from the seed in continuous bands 3 or 4 inches deep.

Fertilizer is also often applied as a side dressing in a narrow furrow along or around these plants while they are growing. Better check with your extension horticulturist on what and how much to use for your various plants.

Leafy vegetables, such as broccoli, cabbage, lettuce, and spinach do well when fertilizers fairly high in nitrogen are used. Root crops (beet, carrot, turnip, sweet-potato, white potato) respond to large quantities of both nitrogen and potassium. Beans, melons, and tomatoes require considerable quantities of nitrogen, phosphorus and potassium. Many other elements are needed as explained above.

A starter solution of commercial fertilizer dissolved in water is used around many garden plants when they are transplanted. The use of $\frac{1}{2}$ pint of starter solution for a vegetable or flower plant speeds up growth and often speeds up both maturity and yield. Set such plants as cabbage and tomato in place and fill the hole partly with water. The starter solution is then poured in and allowed to soak into the soil. Finally, fill the hole with dry soil.

A multipurpose starter solution can be prepared by adding 2 or 3 ounces of a 5-10-5 or 6-10-4 fertilizer to a gallon of water. Stir until most of the fertilizer is dissolved or is in suspension. While using, stir to keep the plant food from settling out. If using a quick dissolving fertilizer which is concentrated, use one ounce per gallon or follow the manufacturer's directions.

The foliar application of fertilizers in dilute concentration is particularly valuable for applying trace elements (e.g., zinc, iron, manganese, boron, calcium, copper, etc.). Many times these materials can be added to regular pest sprays.

Avoid the use of "miracle" fertilizers that claim to contain mysterious plant foods and are sold at outrageous prices.

Applications of fertilizer to trees and

shrubs should be made in the spring or in late fall. For most purposes, use fertilizers with a 2-1-1, 1-1-1, or 1-2-1 ratio. A 2-1-1 ratio would be approximated by a 10-6-4 fertilizer. Examples of a 1-1-1 ratio are 10-10-10, 12-12-12, and 7-7-7. Examples of the 1-2-1 ratio include 10-20-10, 6-10-4, and 5-10-5.

Fertilizer rates for trees are based on the diameter of the trunk at shoulder height. For young trees with trunk diameters from 2 to 6 inches (or large shrubs), use 1 to 2 pounds of fertilizer for each inch of diameter. One pound of commercial fertilizer is enough if it contains 10 to 12 per cent nitrogen. If the fertilizer contains 5 or 6 per cent nitrogen, apply 2 pounds per inch of trunk diameter.

Heavier rates are used for older trees with diameters over 6 inches at shoulder height. With fertilizers containing 10 to 12 per cent nitrogen, use 1 to 3 pounds per inch. Apply 3 or 4 pounds per inch of trunk diameter if the fertilizer has 5 or 6 per cent nitrogen.

The fertilizer should be mixed with 2 or 3 times its volume in topsoil and then packed into a series of holes 6 to 12 inches deep for young trees and 12 to 18 or even 24 inches for larger trees. Bore the holes in the soil with a crowbar or soil auger. The hand auger drill is preferable since it does not compact the soil. Arborists use feeding needles and compressed-air drills. The holes are made about 2 feet apart in the ring and each ring is about 2 feet from the next one (Figure 5). Proportion the total application of fertilizer-topsoil mixture between the holes as given above. Then wet the area thoroughly, using a lawn sprinkler or a fine spray from the garden hose.

Less fertilizer is generally applied for evergreens than for deciduous trees. Fruit and nut trees should be fertilized regularly.

Fertilize shrubs and most garden flowers by spreading the fertilizer in an area under the spread of the branches (Figure 6). The fertilizer should then be worked into the top several inches of soil and the area watered thoroughly. In most cases lawn fertilization is adequate for shrubs growing in the lawn. In borders and foundation plantings, apply fertilizer at the same rate as the lawn requires.

House plants should be fed only when making active growth. From November



Fig. 5. Fertilizing a tree by boring holes in the soil. Make the holes with a crowbar or soil auger. Punch holes 6 to 12 inches deep for young trees and 12 to 18 inches or deeper for large trees. The holes should be 2 feet apart and each ring about 2 feet from the next one. Place about 1 to 3 tablespoons of fertilizer in each hole — or enough to give the total application needed. Keep the rings at least 3 feet away from the trunk of young trees and at least 6 feet on larger trees. The outermost ring should be beyond the drip line of the tree.

through February they need very little, if any, additional feeding. Generally a complete fertilizer is recommended. A level teaspoon to a quart of soil before planting is usually enough. After this apply the fertilizer in solution. Put a level tablespoon of a complete fertilizer in a quart of water. Let it stand overnight before applying. Water regularly to carry the nutrients to all the roots in the pot. Avoid overfertilizing!

To avoid accumulation of excessive soluble salts in the root zone, periodically flush house plants with an amount of soft water equivalent to 5 or 6 times the soil volume. Check with your local florist or extension horticulturist for addi-

tional information regarding fertilizing of house plants.

10. Pruning

When bare-rooted trees and shrubs are transplanted, it is advisable to remove about $\frac{1}{3}$ of the branch system. Even container-grown plants should be pruned. This reduces top growth and compensates for roots lost in moving. Broken, weaker, rubbing, diseased, and overcrowded branches should be removed whenever found. Do not cut back vigorous plants which have been thoroughly thinned out at the nursery. Follow instructions outlined by your nurseryman.

Prune just above a strong bud (Figure

7). Each cut should be smooth. A smooth wound heals more rapidly. Prune to maintain and improve the natural shape of each plant. Correct pruning restores vigor to older plants.

Peaches and nectarines must be pruned every year. Cherries, especially the sour, require little special pruning. Apples and pears may not need much pruning for 5 to 8 years after trees come into bearing. Later, of course, such trees should be pruned regularly.

Judicious pruning results in more vigorous plants, larger blooms, more fruit as well as control of the size and shape of the plant.

A. Shrubs Prune sucker-type shrubs (e.g., spirea) by cutting about $\frac{1}{3}$ of the older mature stems to the ground (Figure 8). Select a few of the better distributed stems (canes) to remain. Leave young vigorous growth. Cut suckers below the ground line and close to the parent stem.

Prune shrubs which come up from a single main stem (e.g., honeysuckle) by removing some old branches at the base and others part way up. Leave young wood. But keep shrubs from becoming overgrown and straggly.

Spring-flowering shrubs (e.g., forsythia, lilac, honeysuckle, spirea, and mock-orange) should be pruned right after flowering. Prune summer- and fall-flowering types (e.g., rose-of-Sharon, hydrangea, snowberry, and butterflybush) in the fall, winter, or early spring before flower buds form. Leave young wood but keep shrubs within bounds.



Fig. 6. Fertilizing a shrub by spreading the fertilizer in a ring under the tips of the branches and beyond. The fertilizer is then worked into the top several inches of soil and watered in.

If plants are grown partly for their attractive fruits (e.g., cotoneaster, pyracantha, and viburnum), delay pruning until the fruit fall.

Prune clipped hedges frequently when young to insure heavy, compact growth. The top should be kept narrower than the base. This helps keep the base of the hedge compact as the bottom gets more

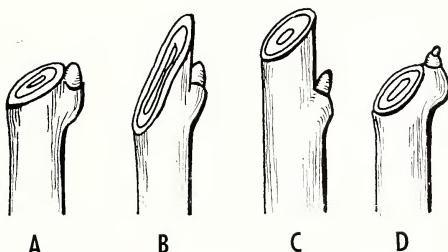


Fig. 7. Pruning in relation to buds. A. Correct surface, B. Too much surface, C. Too long a stub, D. Too close to bud.

light. Do not allow hedges to get taller and wider each year after they reach the desired size. Renovate old hedges by cutting the stems back to the ground.

B. Trees Most trees can be pruned almost anytime during the year "when the knife is sharp" — except bleeders, i.e., maples. To promote quicker and better healing of wounds prune in the dormant season and in midsummer.

Branches that are dead, dying, broken, or rubbing should be removed as soon as possible to improve the appearance and prevent entrance of disease-producing organisms and insects. Remove weaker, crowded, and rubbing branches while they are young. For fruit trees, remove all side branches except those desired to make permanent limbs.

Follow the procedure outlined in Figure 9 when removing limbs or branches. Cuts 1 and 2 are made to prevent stripping of the bark. Make each cut clean and flush with the stem or trunk. Don't leave short, useless stubs! These often lead to eventual wood rot and premature death of the plant.

Trees with narrow, V-shaped crotches (less than 45° angle) are subject to wind-splitting and later wood decay. One branch in the weak union is often removed while the tree is young. The narrow crotch angles of certain trees (e.g.,

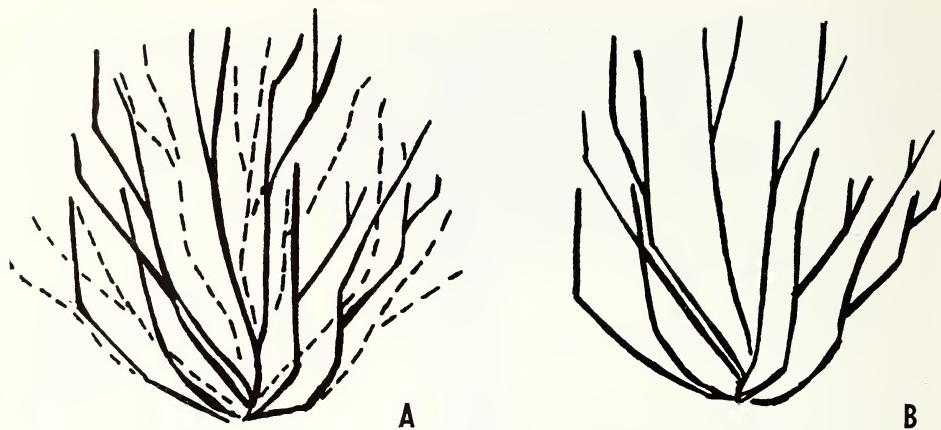


Fig. 8. Pruning shrubs. A. Before, B. After. Prune to maintain and improve the natural beautiful shape of each plant. Remove old, dead, diseased, damaged, and interfering branches.

elms) cannot be corrected in this manner. Here pruning back to the lower branches to reduce their weight, plus cabling and bracing is often necessary.

The lower branches of shade trees growing in lawns or along streets and sidewalks should be removed while they are still small enough to cut off with hand shears. Continue each year until the lowest branch is the height you want it from the ground when the tree is mature (usually 8 to 12 feet).

Narrow-leaved evergreens (e.g., yew, juniper, and arborvitae) may need an occasional light shearing to thicken the plants and keep them within bounds. Shear in late spring or early summer.

Prune pines frequently to keep them compact. Do this in late spring when the new candle growth is full-grown but still soft. Firs and spruces require little pruning. Do it from late summer to winter. A little pruning of evergreens every year or two prevents a drastic operation at any one time.

For additional help with your pruning problems contact your county agent or extension horticulturist. Many states have excellent pamphlets on this subject. The services of an experienced, responsible tree specialist should be employed for major pruning and for all hazardous aerial work.

11. Tree Removal

All dead, hollow, seriously diseased and structurally weakened shade trees are potential hazards to life and property. Such trees should be removed. As this job is hazardous, except in simple cases, it is important to secure the services of a competent arborist.

12. Treatment of Wounds

Wounds are treated to (1) prevent drying of the tissues, (2) avoid infection by rot-producing organisms and insects, and (3) promote faster healing.

Bark wounds and pruning scars should be promptly treated. Pruning cuts less than about an inch in diameter are not normally treated. Vigorous, well-maintained trees heal faster than sickly, undernourished ones.

To heal quickly and properly, large wounds should be shaped. All splintered or diseased wood and bark should be removed cleanly with a sharp-edged knife or chisel (Figure 10). Avoid leaving pockets where water may collect. If the job looks too big, call in a trained arborist. The margins of large wounds should be painted with shellac to prevent drying out. After protecting the margins, and excavating the cavity, all exposed wood should be sterilized by swabbing with a household bleach (diluted 1 to 5 with



A



Fig. 9. Pruning trees — the right way and the wrong way. A. Tree topping "butchery." This is **not** a recommended way to prune trees (Courtesy Ottumwa, Iowa, **Courier**). B-D. The correct way to remove a large branch. B. Cut no. 1. C. Cut no. 2 severs the main part of the branch. These preliminary cuts prevent stripping of the bark. D. Final cut, made flush with the trunk, removes the stub. The wound should be promptly painted with a tree wound dressing.

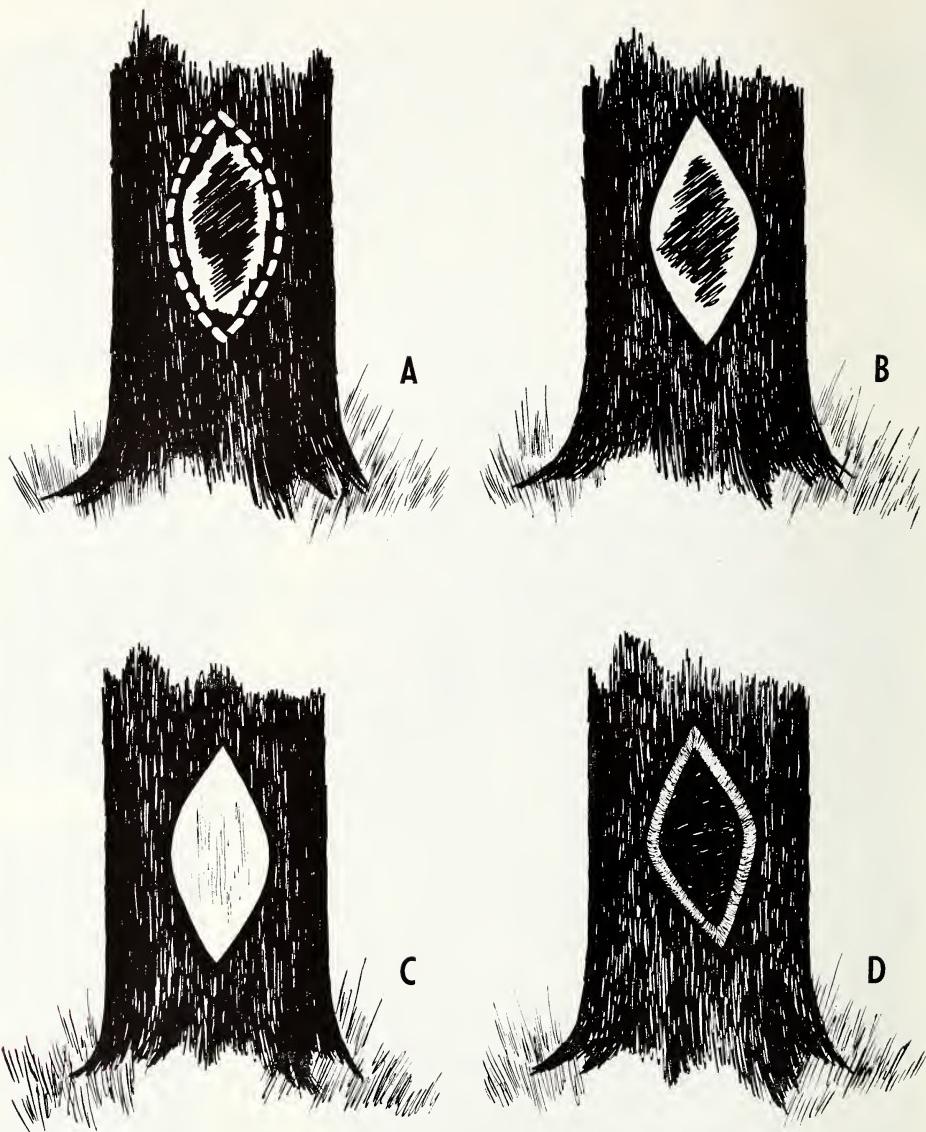


Fig. 10. Treating a tree wound. A. The dotted line indicates proper shaping for an irregular trunk wound. All margins should be cut back to live, healthy bark tissues. B. The bark has been removed cleanly together with some of the discolored or rotted wood beneath. The margins of the cut should be painted now with orange shellac. C. The wound has been completely cleaned and is ready to be painted with a tree wound dressing. D. Some time later. The old wound has been painted and rolls of callus growth are closing over the cavity.

water) or a 1:1,000 solution of mercuric chloride. See page 85 for details on how to prepare this solution and precautions to follow.

Finally, all wounds should be painted with a permanent-type tree wound dressing.

(1) Asphaltum-base tree paints with gilsonite varnish are widely used and are available from many horticultural supply houses, garden supply stores, and nurseries. They are also available in aerosol-type cans. Those containing turpentine or coal tar will injure growing tissues. Buy a type containing a disinfectant (e.g., 0.25 per cent phenyl mercuric nitrate).

(2) Outside-type house paints are fairly satisfactory if properly mixed with raw linseed oil. Use only after first coating the wound with orange shellac.

(3) Bordeaux paint makes a good tree wound dressing. Prepare by slowly stirring raw linseed oil into fresh, dry, commercial bordeaux powder until a thick, sticky paint is produced. If you object to the blue-green color of the bordeaux, add lampblack suspended in oil. The disadvantages of bordeaux paint are that it hinders rapid healing during the first few years, and it has rather poor weathering qualities.

(4) The newest, and probably the best, tree wound dressings contain a mixture of lanolin, rosin, and gum. Some also have a disinfectant added to these ingredients (see above). You can prepare a good tree paint by melting and stirring together 10 parts by weight of lanolin, 2 parts of rosin, and 2 parts of crude gum.

Tree wound dressings are also available in convenient aerosol bombs.

Wound dressings should be checked periodically. Recoat once or twice a year when the surface cracks, peels, or blisters.

For additional information on treating wounds and cavities, as well as many other types of tree injuries, secure a copy of USDA Farmers' Bulletin No. 1726, *Treatment and Care of Tree Wounds* and Farmers' Bulletin No. 1896, *Care of Damaged Shade Trees*.

The United States Department of the Interior, National Park Service, Tree Preservation Bulletin No. 3, *Tree Bracing*, gives an excellent account of the proper ways to cable and brace trees. Some of the same information is also given in Farmers' Bulletin No. 1896.

All USDA bulletins mentioned above, or elsewhere in this book, are available by writing to the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D.C. There is often a small handling charge (usually 5 to 25 cents).

To get a complete listing of United States government bulletins currently available, call at your county extension office.

13. Staking Trees and Shrubs

Just after planting in windy locations, treelike shrubs and small evergreen trees should be guyed (Figure 11) or supported by means of a single, stout stake driven into the ground on the windward side about a foot from the trunk. Care should be exercised to prevent damage to the root system. Attach the tree to the stake with guy wire threaded through scrap garden hose or larger tubing. Burlap with sash cord or light rope works nearly as well. Stake street trees, up to 3 inches in diameter, with two stakes on opposite sides of the tree about 18 inches from the trunk. Street trees of 4- to 6-inch diameter should have 4 stakes in a box formation 18 inches from the tree.

Guy shade trees up to about 5 inches in diameter from three directions as shown in Figure 11. Guy wires are usually removed the second year after transplanting, except in windy areas. Permanent guys (one or double strands of 12-gauge wire) should be attached by eyebolts or lag hooks inserted into the trunk or branches; never wrapped around them.

14. Soil Drainage

Soil underlaid with an impervious layer of clay, hardpan, or rock which drains poorly, may kill sensitive plants (e.g., roses, most evergreens). When water collects above this impervious layer, the soil becomes saturated (waterlogged). Home owners usually assume that sloping land provides sufficient soil drainage. This is often a false assumption because the soil below the surface may be tight, resulting in poor drainage. Water remaining in the root area forces air out, causing the roots to die from suffocation. This condition may kill plants outright or cause stunted and yellowish growth with reduced yields of flowers and fruit. Unless tolerant plants are grown, such soils should be drained by

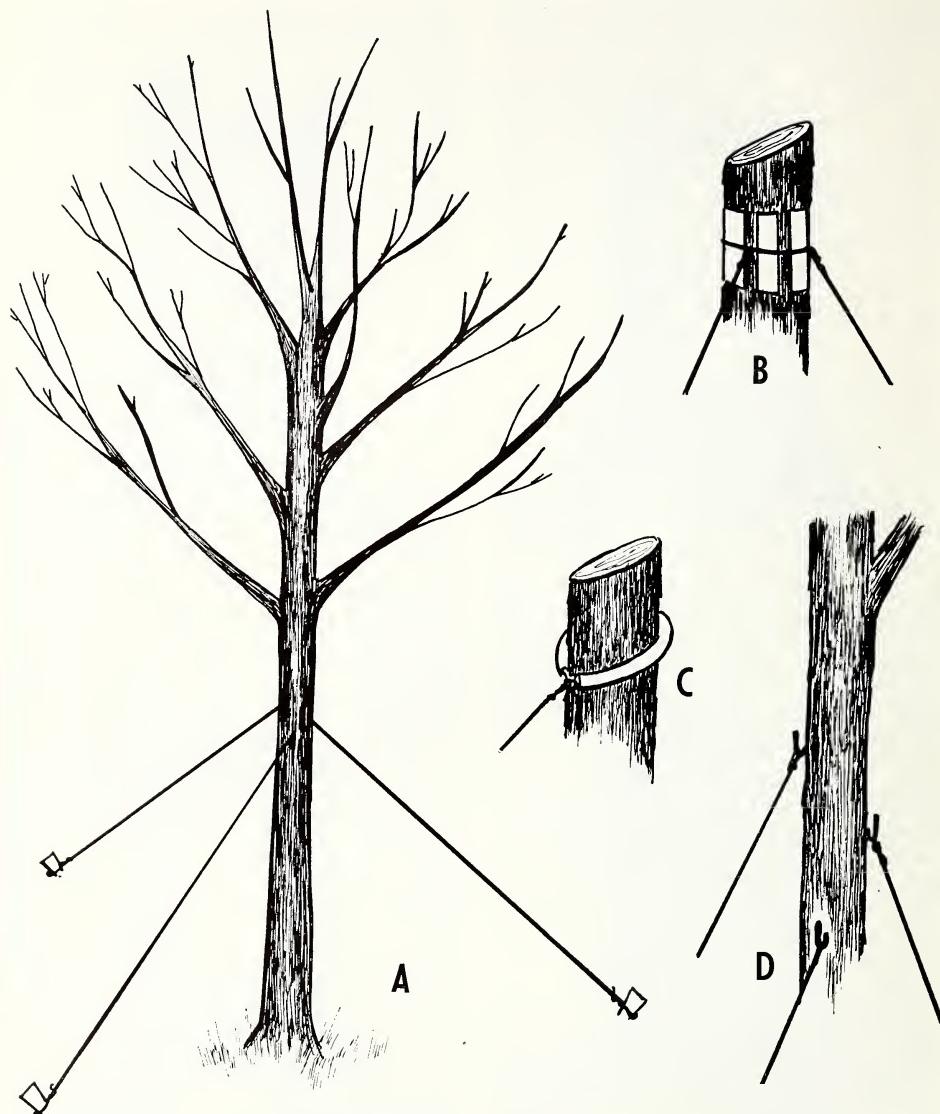


Fig. 11. Guying trees. A. All three guy wires should have the same tension. D. The best method of fastening wires to trees using lag hooks, eyebolts, or screw eyes. B and C. Less satisfactory methods.

deep tillage (using a subsoiler or lister). Installing gently sloping lines of agricultural drain tile every 20 to 25 feet at a depth of 2 or 3 feet usually provides a permanent cure for a waterlogged soil.

Check with your county agent if you have soil drainage problems.

If soil is permanently waterlogged or swampy (oxygen deficiency or asphyxiation) and cannot be drained, it may be

necessary to grow plants adapted to these conditions (e.g., bog plants).

Lack of vigor and off-colored foliage are two signs of poor soil drainage. Your soil should have good natural drainage to a depth of at least 2 feet, preferably deeper for trees.

15. Watering

Excessive moisture, droughts, or unfavorable temperatures cannot always be prevented, but their injurious effects can often be reduced. During hot, dry periods shrubs need extra water, especially when growing in a lawn. Plants lose water rapidly under such conditions and unless watered, severe wilting, withering, and death often result. Almost the same symptoms may follow excessive rainfall and overwatering. It is not true that plants are injured by watering on a hot, sunny day.

Shrubs and trees planted in the spring usually die during hot summer weather if the soil is not kept sufficiently moist. During droughts, plants in unfavorable locations (light sandy soils, slopes, winds, or full sun) are the first to suffer. Leaves may wilt, become scorched, and drop prematurely. If many of the feeder roots are killed, the entire plant may die. Injured trees and shrubs usually die slowly over a period of one or two or more years. Timely detection and treatment could save many valuable plants.

Drying out of soil is often disastrous for pot plants, evergreens, newly planted trees, shrubs, transplants, and new lawns. Grass and garden plants growing beneath trees, or areas filled with tree and shrub roots are difficult to keep watered.

Maximum growth from most plants in roughly the eastern half of the United States comes when they have an equivalent of an inch of water (from rainfall or irrigation) a week during the growing season. Much more water than this is needed in arid areas of the western states where moisture is greatly deficient. During droughts, water enough so that it soaks the soil to a depth of at least 8 to 12 inches, preferably more for deeper-rooted plants. After the sprinkler has been on an hour or more in the same spot, use a trowel to check the depth of water penetration.

House plants should be planted in light, well-drained soil and not overwatered. Nearly all of these plants require a steady supply of water with the exception of cacti. A drainage hole should be present in the bottom of the growing container. Only experience will tell you how much water your house plants need. Lack of water causes wilting, leaf scorch, early dropping of leaves, root injury, and stunting among other troubles.

Does your home have wide, overhanging eaves? Do you always remember to give the soil underneath extra water? If you live in a windy location or in a dry region, it is even more necessary that perennial plants, especially evergreens, have adequate moisture during late fall and winter.

16. Light

Plants vary greatly in their requirements for light. Some thrive best in full sunlight; others need shade or partial shade to do their best.

Extremely high light intensity, especially during hot weather, may cause sunscalding of fruits and vegetables or result in the fading of deep flower colors. Valuable plants may be at least partially protected by spraying the foliage with a material like Wilt-Pruf before scorching occurs.

The duration of the light also affects flowering and fruiting. Short-day plants such as chrysanthemum, cosmos, tuberous-rooted begonia, and poinsettia bloom when the day length is 12 hours or shorter. Long-day plants such as corn and peas are stimulated to flower when the day length is 14 hours or longer. Other plants such as tomato are day-neutral and do not respond to short or long days.

When planning your foundation and garden plantings, check on the light requirements for the various plants you plan to grow. This will save you both money and later grief. Shrubs for the north side of a home must be selected for shade tolerance.

Most flowers, vegetables, and flowering shrubs (e.g., lilac, viburnum, spirea) require full sun for at least a part of the day. Such plants as laurel, rhododendron, and azalea will blossom in partial shade.

Give most house plants as much light

as possible, especially during the winter months. Such plants should be placed by a window, except plants that do not thrive in strong sun (e.g., ferns, begonias, cyclamen, African-violet, and foliage plants). To produce flowers, most house plants need 3 to 5 hours of direct sunlight a day. A lack of sufficient light often leads to pale green leaves, spindly growth, leaf drop, and loss of flowers.

Artificial light may be supplied by fluorescent tubes to provide from 300 to 600 foot candles at the top of the plants. Give most plants 12 to 18 hours per day of this supplementary light, if needed.

17. Oedema

A common problem with indoor plants. Small masses of leaf or stem tissue may expand and break out, causing watery swellings or galls. Later the exposed surface may become rusty in color and corky in texture. Control by reducing air humidity, increasing light and air circulation, plus avoiding overwatering especially during overcast periods. Oedema is a nonparasitic disease.

18. Air Humidity

The low humidity in a city apartment or modern home is often responsible for the leaves of begonias, ferns, rubber plants (*Ficus*), and others becoming spotted or scorched and falling prematurely. Plants taken from a cool, moist greenhouse or florist's shop to the hot (75° to 85° F.) dry air of a home are commonly affected. Many times the flowers suddenly drop off. Control by increasing the humidity around susceptible plants and reducing the temperature. Buy a ready-made humidifier or build one yourself. Set plants on an inverted pot over a large pan of water, in a glass or plastic case, or in a planter filled with sphagnum moss or other filler which is thoroughly wet down occasionally. Evaporation of a gallon of water a day for the average room should moisten the air enough for plants. Your florist can also provide tips on increasing the air humidity during dry periods such as winter.

The average home is too dry for fungus or bacterial diseases to develop on the foliage of house plants.

19. Temperature

Most house plants do best if the daytime temperature is between 65° and 75° F. and at night 55° to 60° F. Most modern homes are too warm for the best growth of many house plants. Since it is often not practical to keep the temperature within the limits outlined, there are two alternatives: (1) select plants that "get along" at higher temperatures, or (2) replace flowering house plants after several weeks when blossoming is complete.

For top results, place your flowering plants in cool locations at night, away from radiators and heat registers. Avoid putting such sensitive plants as African-violet close to windows during cold, winter weather.

Vegetables, too, are sensitive to temperature. Cauliflower and head lettuce grow best in cool weather. Celery, cabbage, and certain other vegetables may shoot up seed stalks if the temperature is 50° F. or below for a period of time when plants are young. Tomatoes and peppers often drop their blossoms during temperature extremes when night temperatures range from 55° to 60° F. and day temperatures are about 95° F. or above. High temperatures are also responsible for the premature flowering of spinach, broccoli, and lettuce and the low yield of garden peas and beans.

20. Scorch or Sunscorch

During very hot (90° F. or above), dry, windy weather the tips and margins of the leaves on many plants, especially trees, turn brown and wither (Figure 1B). Injury occurs when water is lost by the leaves faster than it can be replaced by the roots. Scorching may progress inward until entire leaves turn brown and wither. Such symptoms may also be caused by other conditions or by a parasite. Sunscorch can often be checked by watering plants during summer droughts, pruning to open up trees and shrubs, mulching plants, and shallow cultivating.

21. Winter Injury

Trees and shrubs growing in exposed, windy locations or in poorly drained soils

may be injured by low temperatures, alternate freezing and thawing, or drying winter winds. Plants overfed with a high-nitrogen fertilizer or those still actively growing in late fall are most commonly injured. Frost cracks, a vertical separation of the bark and wood, are common on many young, thin-barked trees on the south or southwest sides of the trunk. Injury to broad- and narrow-leaved evergreens occurs following extreme and rapid fluctuations in temperature or by early fall or late spring freezes. Plants growing in sunny areas are most subject to injury.

Plants prone to winter injury and sunscald may be grown where shaded from midday or late afternoon sun — or shade may be provided by a cheesecloth or lath screen. Protect trunks of young, thin-barked trees from winter sunscald and

Plant Cote) spray in autumn. Evergreens should be watered during late fall and early winter. Then apply a 2-inch mulch of sawdust, shavings, peatmoss, or leaves. Mulching helps prevent deep freezing or alternate freezing and thawing after the ground is frozen, allowing more water absorption by the roots.

A sharp variation in soil and air temperatures may cause abnormal growth. Low winter temperatures and late spring or early fall freezes may cause injury similar to burning, especially if the plants have made late, tender growth.

Check with your extension horticulturist or county agent on what, how, and when to apply winter protection to your garden plants. He can help you select plants which are adapted and will do well in your particular location.

Additional help can be obtained by studying the USDA Miscellaneous Publication No. 184, *Plant Hardiness Zone Map*. Numerous indicator plants are listed for each of the 10 hardiness zones in the United States.

22. Chemical Injuries

Sometimes in and near large cities such as Los Angeles, smelters, factories, and incinerators create impurities in the air which result in leaf discoloration or poor growth. These impurities include ethylene, fluorides, herbicides, oxidized hydrocarbons (smog), ozone, and sulfur dioxide. Plant responses to polluted air may depend on the plant variety, soil fertility and moisture, and the temperature.

Ingredients in automobile exhaust fumes contain products which are harmful to plants. Smog damage in large cities can be prevented by spraying susceptible plants with Ozoban (Charles Pfizer & Co.) or other trade products containing ascorbic acid. Fungicide sprays containing zineb, maneb, ferbam, dichlone, or thiram often reduce damage. Sprays should be applied periodically during the smog season. Check with your local nurseryman or extension horticulturist.

Salt injury, whether it occurs along a seacoast where salt water sprays are blown inland or along sidewalks and driveways where salt is applied for weed control may cause scorching and killing of leaves similar to that caused by certain diseases. Salt

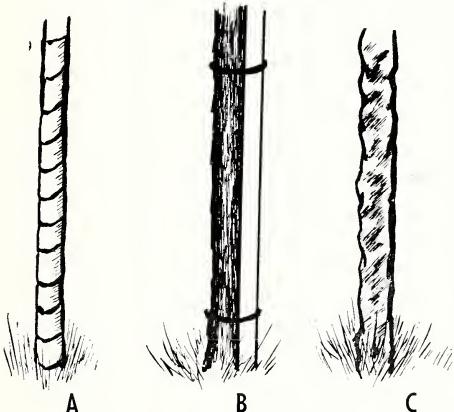


Fig. 12. Three methods of protecting trees against winter injury. A. Wrapping with sisalkraft paper or burlap, B. Use of a 6-inch board on the south side, C. Wrapping young trees with aluminum foil.

frost cracks by wrapping with burlap strips, sisalkraft paper, aluminum foil, or just tie a 6-inch board upright on the south side of the tree (Figure 12).

Protect exposed evergreens from leaf scorching, caused by drying winter winds and sun, by erecting canvas or burlap screens on the south and southwest sides. Better still, plant in a more protected location! Try covering the foliage with a special "no-wilt" (e.g., Wilt-Pruf or

applied on country roads or driveways to keep down dust, or on city streets to speed the melting of snow and ice may damage tree roots when washed or swept down into the soil.

Trees, shrubs, and other plants often show scorched leaves and wilt along streets or other places where manufactured illuminating gas lines are buried. When these lines develop leaks, the gas penetrates and poisons the soil, killing nearby plant roots. Sudden or gradual severe wilting, dieback, or other peculiar symptoms, frequently occur depending on the size of the leak and the period of time illuminating gas has been escaping. If you suspect poisoning, call the gas company. Natural gas, which has largely replaced illuminating gas, supposedly does not contain the plant-toxic materials (e.g., unsaturated hydrocarbons, hydrogen cyanide and carbon monoxide) found in manufactured illuminating gas.

Well-established plants sometimes are damaged by too much care (excess water or fertilizer or both) by overanxious home owners and careless workers.

Careless use of weed killers may result in severe injury or even death of trees, shrubs, and annual plants. Weed-killing chemicals containing 2,4-D, 2,4,5-T, Amitrol, or arsenicals should be used with extreme care. Follow the manufacturer's directions to the letter!

The pesticides recommended in this book will not normally cause damage to plants if applied according to the manufacturer's directions on the plants specified, at the rates specified, and at the times specified. Injury is most apt to occur on tender growth or when plants are in a wilted condition. Bordeaux mixture and other copper-containing fungicides may cause a scorching and spotting of leaves on certain plants during cool, wet weather. Copper-injured plants may be stunted with blossoming and fruit-setting delayed. Sulfur, Karathane, Acti-dione, and the so-called dinitro materials may cause scorching in hot (above 85° F.) dry weather. Insecticides, including dormant oils, arsenicals, malathion, parathion, DDT, and nicotine sulfate may also damage certain types of plants. Precautions are usually listed on the package label.

23. Mechanical Injuries

Mechanical damage caused by lawn mowers, automobiles, hailstones, wind, ice

and snow, and boys' knives often results in poor growth, weakened plants, and wood rot. Such injuries should be treated promptly (Figure 10).

Strangling tree roots which grow tightly around the trunk and other roots may weaken and kill trees. Such girdling roots, which may be above or below ground, should be cut off with a chisel and mallet and the exposed surface painted. You can help decrease the possibility of girdling roots by spreading the roots out naturally when planting (see 1 above). Treating of girdling roots may also be a job for a good arborist.

Digging a basement or foundation near large trees results in the cutting away of many valuable feeding roots. If the wounds are not promptly treated, wilt and root-rotting fungi may enter. The water table for the remaining roots may be changed. The effect may cause death of trees.

Construction Damage Construction damage to shade trees is common by sloppy workmen building a new home. Tree roots are broken, cut, or exposed—or trunks are brutally scraped. Tractors and bulldozers compact the soil making conditions unfavorable for root development. Injury to tree roots also occurs when trenches for utility lines are dug or lawn grading occurs.

Cuts and bruises permit easy entrance for rot-producing fungi which commonly attack weakened trees and shrubs. Be sure wooden or metal barriers are put up to protect valuable shade trees while construction is going on.

Changing the Soil Grade Another common construction damage problem for new homes is a change in soil grade around trees. Roots are exposed when soil is removed or a heavy, compacted, clay soil fill smothers the root system. Even several inches of this type of fill can kill old, shallow-rooted trees. Trees suffering from too much fill soil will have smaller leaves than normal, and dying back of the outer and upper twigs and branches occurs. Sucker growth on the trunk is common. Fill-injured trees may take up to 10 years to die.

Nothing can be done to save trees buried under a fill for a long time, which have dead or dying tops. Recent fills, or trees which are apparently not suffering seriously from older fills can be treated.

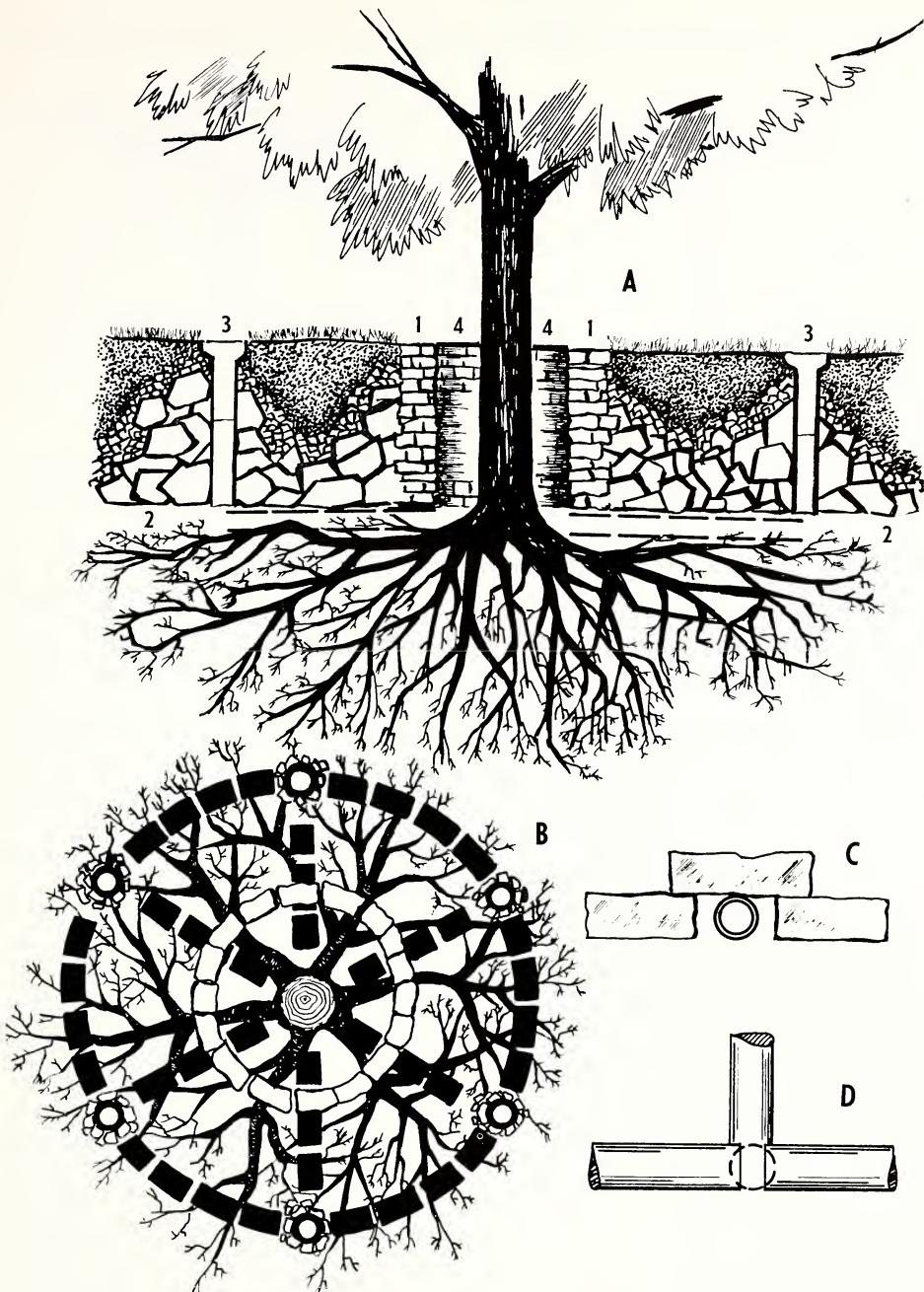


Fig. 13. Preventing injury when constructing a deep soil fill. A. Side view showing (1) the dry well; (2) ground tile, sloped to drain away from the trunk and off the roots; (3) vertical bell tile, connected with the drain; (4) metal grating to prevent falling into dry well. The tiles (2) and (3) are covered with rock and coarse gravel except for a foot of topsoil. B. Top view of A showing the trunk at the center surrounded by a dry well with 6 lines of tile radiating out to the ends of the branches. The ground tiles are connected by a row of tiles around the outside. Upright bell tiles are at all intersections. C. Protecting arch of stone is placed over drain tiles to prevent breakage. D. Vertical bell tile rest on the ends of horizontal ground tile that are spaced to allow for air circulation.

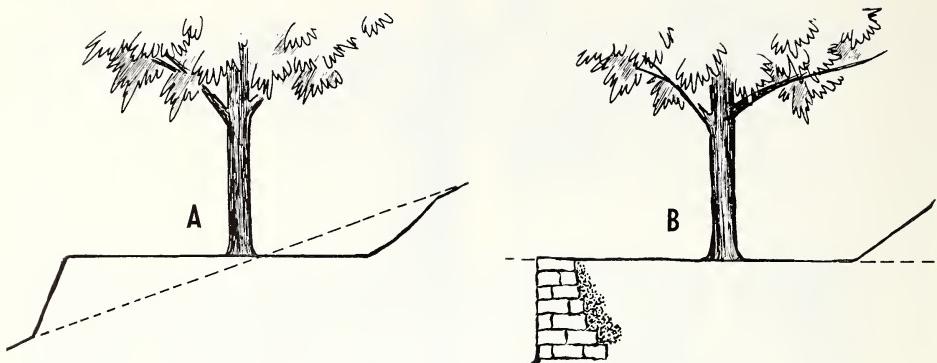


Fig. 14. Preserving a maximum of roots when lowering a soil grade. A. By terracing, B. By erecting a retaining wall. The original soil grades are shown by the dotted lines.

Start corrective treatments at once. Attempt to recreate, as much as possible, the prefill conditions. Where a fill is absolutely necessary, use a rock or brick well around the tree. Installing a wagon wheel design of tile drainage over the root area before making the fill is recommended for deeper fills (Figure 13). No single method of constructing fills over tree roots fits all circumstances. An excellent USDA Farmers' Bulletin, No. 1967, *Reducing Damage to Trees from Construction Damage*, covers this subject in detail. Before making grade changes around large trees, call in an experienced landscape architect or arborist for his advice.

24. Electrical Injuries

Lightning damage is quite common, particularly on tall, isolated trees such as elm, maple, oak, pine, poplar, and tulip or yellow-poplar. Trees may suffer no permanent damage, show streaks of split bark and wood which extend to the ground line, or be completely shattered. If you suspect lightning damage, call in a competent arborist. Lightning-protection equipment is available for trees.

Wires carrying electric current through trees, or near trunks and branches, should be covered with nonconductors at critical points. Be sure that the lights used on outdoor Christmas trees are properly placed and equipment is not worn. You don't want to damage that prized evergreen.

25. Check and Double Check

Before blaming an infectious disease for an ailing plant, check the soil, water supply, light requirements, winter protection, and other factors mentioned above. Have you carried out recommended cultural practices in planting, pruning, and fertilizing? Is an insect, mite, or rodent pest involved? How about spray or fume injury? If you eliminate all these, and the other possibilities outlined above — then one or more infectious diseases may be the answer. Find out exactly what is wrong and resolve to start control measures earlier next year.

When investigating a plant trouble, examine the symptoms carefully. If you suspect an infectious disease, read the disease descriptions listed under the plant involved. Think back and consider what else might have gone wrong. But don't rush out and buy a new spray or dust "because the old one didn't work." Remember, by the time the blight, rot, or leaf spot is serious enough to be noticed, it's probably too late for spraying or dusting to do much good this season anyway.

A leading plant doctor, Dr. Cynthia Westcott, once said, "The chief hazard any garden plant has to endure is its owner or gardener." She also says don't jump to conclusions when a plant becomes sick.

26. Here We Go

Most plant diseases are named in accordance with their most conspicuous

symptom or symptoms, just as many human and animal diseases are described.

Diseases which, in general, look alike have often been lumped together even though they may be caused by different organisms. This is possible where control measures for each are the same. Where control measures are different, these have been pointed out under the plant involved.

We have arbitrarily divided the different general types of diseases into those which principally attack the foliage, stems (including trunks, branches, and twigs), roots, flowers and fruit. Many times the same organism attacks more than one plant part and hence may be listed in more than one category.

Although the diseases listed are based on records in the continental United States, a majority of these diseases is found wherever these plants are grown in the world.

GENERAL DISEASES

A. Foliage Diseases

(1) Fungus Leaf Spot Usually a rather definite spot — of varying size, shape, and color depending on the cause. Often with a distinctive margin. Spots are often zonate or marked with conspicuous concentric zones. If they are numerous, or if they enlarge, diseased areas may join together forming irregular *blotches* or a *blight*. Infected leaves may wither and die prematurely. See (3) Leaf Blight. Certain leaf spots have special names such as *black spot*, *tar spot*, *spot anthracnose*, or *anthracnose*. The centers of some spots may fall out leaving holes. See (4) Shot-hole.

Leaf spots are the most common of all diseases. They are favored by wet seasons, high humidity, and water splashed on the foliage.

Plants Attacked: Practically all plants.

Control: Most leaf spots are not serious enough to warrant special measures. Where practical (or possible), collect and burn infected plant parts when first evident and at the end of the growing season. Rotate garden plants avoiding members of the same plant family in the same soil in successive years. Plant disease-free seed or treat as directed under the plant in

question and in Table 13 in the Appendix. Control insects and mites (which may carry the causal fungus around) using malathion plus DDT or methoxychlor. Follow the suggested spray or dust program for the plant involved. Use captan, zineb, maneb, ziram, or a copper-containing fungicide. See Section 3 for information about these chemicals.

Protection for trees and shrubs is usually needed when leaves are expanding in the spring. Some plants such as roses, tomatoes, and apples may need regular applications through the growing season. Keep plants vigorous by fertilizing and watering. Grow resistant varieties when available. Indoors, keep water off the foliage and the humidity as low as practical. Too low humidity probably causes more damage to house plants than organisms producing leaf spots and blights. Increase air circulation by spacing plants, especially those in shaded areas, plus removing the lower 4 to 6 inches of foliage on certain plants (e.g., phlox, chrysanthemum, and roses).

(2) Bacterial Leaf Spot or Blight, Bud Rot

Symptoms variable; dark, water-soaked spots or streaks often develop on leaves and stems which later turn gray, brown, reddish-brown, or black. Spots may even drop out leaving ragged holes. Leaves may wither and die early. On *crucifers* (cabbage, cauliflower, and related plants) V-shaped, yellow, brown, or dark green areas develop in leaves with blackened veins. See also (15C) Bacterial Wilt, (24) Fire Blight, and (29) Bacterial Soft Rot.

Plants Attacked: Aconitum, almond, apple, apricot, arrowwood, artemisia, asparagus-bean, avocado, barberry, bean, beet, begonia, belamcanda, blueberry, boxelder, broccoli, Brussels sprouts, bryonia, butternut, cabbage, California-laurel, California-poppy, canna, cantaloup, carnation, carrot, cassaba, castor-bean, catnip, cauliflower, celery, cherry, cherry-laurel, chicory, Chinese cabbage, Chinese hibiscus, Chinese lanternplant, chrysanthemum, collards, corn, cotton-rose, cucumber, cranesbill, currant, delphinium, dieffenbachia, eggplant, endive, English ivy, escarole, European cranberry-bush, ferns, filbert, flowering almond, flowering cherry, forsythia, gardenia, geranium, gladiolus, gourds, grapefruit,

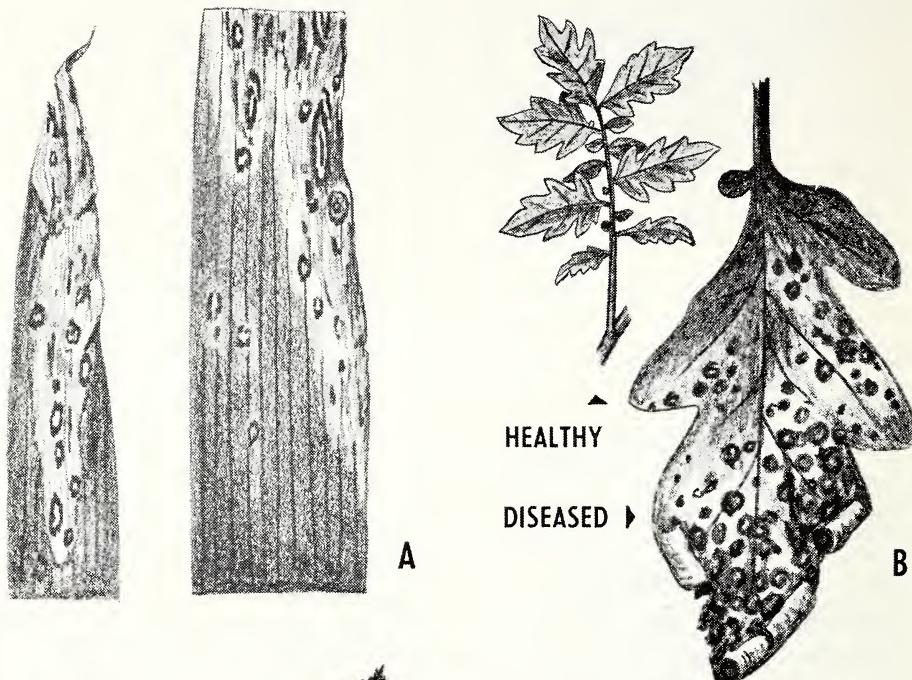


Fig. 15. Four leaf spots caused by fungi. A. Iris leaf spot, B. Septoria leaf spot of tomato, C. Black spot of rose, D. Strawberry leaf spot.

groundcherry, hazelnut, heronsbill, hibiscus, honeydew melon, horseradish, hyacinth, hyacinth-bean, iris, Jerusalem-artichoke, kale, kohlrabi, larkspur, lettuce, lilac, magnolia, maple, monkshood, mulberry, muskmelon, mustard, narcissus, nasturtium, nectarine, onion, orange, orchids, palms, pea, peach, pear, pepper, philodendron, plum, poinsettia, poppy, potato, primrose, privet, proboscisflower, scarlet runner bean, pumpkin, pyracantha, radish, rape, rhubarb, rose, rose-of-Sharon, rutabaga, seakale, squash, stock, sunflower, sweetpea, tigerflower, tomato, tree-tomato, turnip, viburnum, walnut, watermelon, and West Indian gherkin.

Control: Same as for (1) Fungus Leaf

Spot except use sprays or dusts containing copper or streptomycin or a combination of both. See under the plant involved.

(3) Leaf Blight, Leaf Blotch, Anthracnose

(A term originally associated with diseases caused by certain types of fungi.) , **Needle Blight, or Cast of Evergreens** Leaves often suddenly and conspicuously spotted. Spots often later enlarge and usually become angular to irregular in shape. Affected leaves and stems often wilt, wither, die, and may fall prematurely. Fruit may sunscald. Stems and twigs may die. Tops of vegetables and flowers may be killed. See (21) Crown Rot and (24) Fire Blight.

Plants Attacked: Abutilon, African daisy, allium, almond, alternanthera, amaranth,

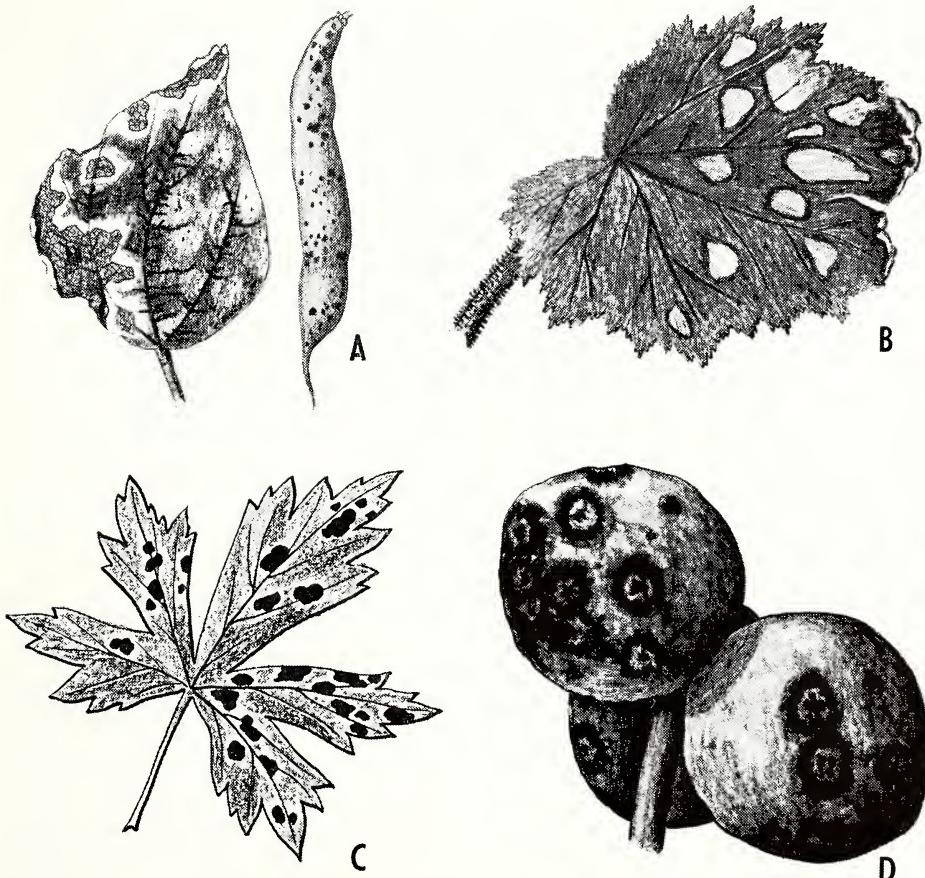


Fig. 16. Bacterial leaf spots and blights. A. Bacterial blight of bean, B. Bacterial leaf spot of begonia, C. Delphinium black blotch, D. Bacterial blight of English walnut.

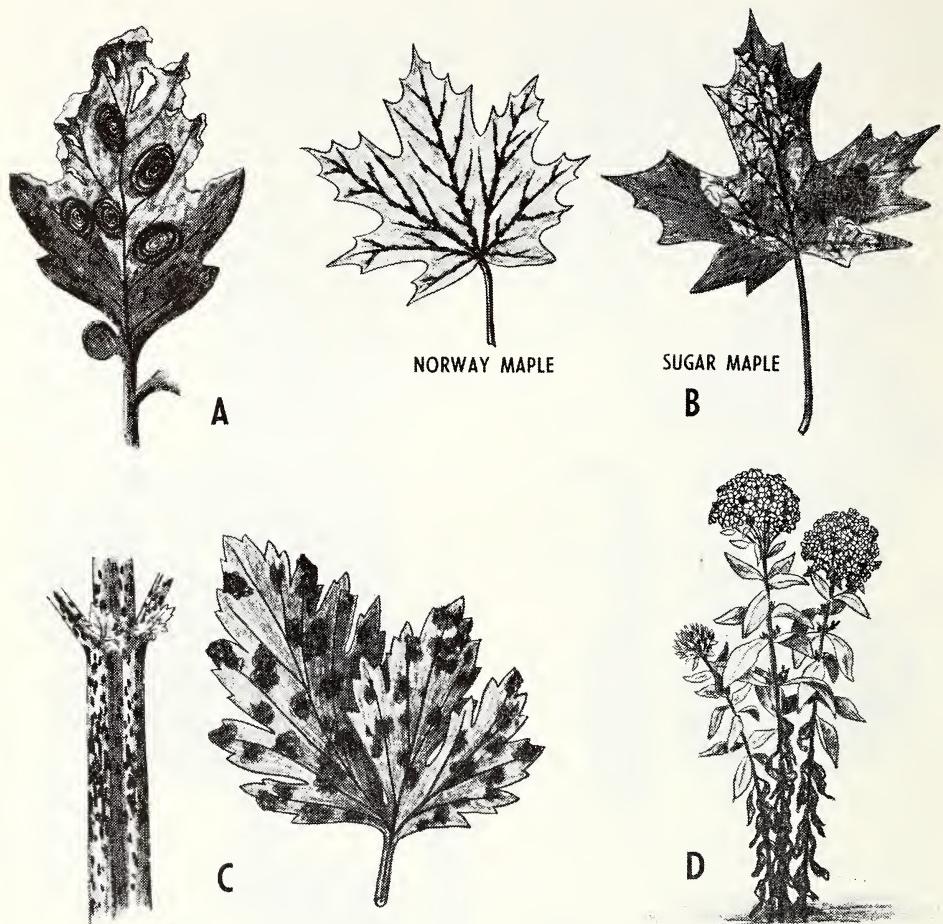


Fig. 17. Leaf blights. A. Early blight of tomato. B. Anthracnose of Norway and sugar maples. C. Late blight of celery. D. Leaf blight of phlox.

amaryllis, Amazon-lily, amelanchier, apple, apricot, arborvitae, arbutus, arctotis, artemisia, ash, asparagus, asparagus-fern, aspidistra, aster, aucuba, avocado, azalea, balloonflower, balsam-apple, balsam-pear, barberry, bean, beet, begonia, bentgrass, Bermudagrass, birch, blackberry, blueberry, blue-eyed grass, bluegrass, Boston ivy, buffalograss, boxelder, boxwood, boysenberry, broom, butter-and-eggs, buttercup, butterfly-flower, butternut, buttonbush, cabbage, cacti, caesalpinia, calendula, California-laurel, calla, camellia, camphor-tree, cantaloup, cape-cowslip, cape-honeysuckle, carnation, carpetgrass, carrot, cassaba, cassabana,

castorbean, catalpa, cauliflower, celery, celeriac, centipedegrass, centuryplant, ceriman, chamaecyparis, chayote, cherry, cherry-laurel, chestnut, chicory, China-aster, Chinese cabbage, Chinese evergreen, Chinese waxgourd, Christmas-rose, chrysanthemum, cinnamon-tree, citron, clarkia, clematis, cockscomb, collards, coralberry, coriander, corn, cosmos, coton-easter, crabapple, crapemyrtle, crassula, crinum, croton, cryptomeria, cucumber, currant, curuba, cyclamen, cypress, daffodil, dahlia, daisy, daphne, daylily, delphinium, dewberry, dieffenbachia, dogwood, Douglas-fir, dracaena, eggplant, elm, endive, English ivy, erythronium, euony-

mus, European cranberry-bush, fall daffodil, false-garlic, feijoa, ferns, fescue grass, fig, fir, flowering currant, flowering quince, forsythia, foxglove, garden cress, garlic, gentian, geranium, gherkin, giant sequoia, ginkgo, gladiolus, gloxinia, gooseberry, gourds, grape, grapefruit, guava, Guernsey-lily, hackberry, hardy orange, hawthorn, heliopsis, hemlock, hen-and-chickens, hibiscus, hickory, holly, holly-hock, honeysuckle, horsechestnut, horseradish, hosta, houseleek, huckleberry, incense-cedar, India rubber tree, iris, Jack-in-the-pulpit, Japanese plum-yew, Japanese quince, jetbead, juniper, larch, kerria, larkspur, lavatera, leek, lemon, lemon-verbena, lettuce, lilac, lily, lily-of-the-valley, lime, linden, lippia, locust, London plane, loosestrife, loquat, lupine, lychnis, madrone, mallow, maple, Mayapple, medlar, mignonette, mint, mitella, mock-cucumber, montbretia, mountain-ash, mountain-laurel, muskmelon, mustard, nandina, narcissus, nectarine, nephthytis, nightshade, oak, okra, oleander, olive, onion, orange, orchids, Oregon-grape, osage-orange, pachysandra, palms, pansy, parsley, parsnip, pawpaw, pea, peach, pear, pea-tree, pecan, peony, peperomia, pepper, persimmon, petunia, philodendron, phlox, photinia, pine, pinks, pistachio, planetree, plum, poinciana, poinsettia, pomegranate, poplar, potato, potentilla, primrose, privet, pumpkin, pyracantha, pyrethrum, quince, radish, rape, raspberry, redcedar, redtop, redwood, retinospora, rhododendron, rhubarb, rose, roselle, rosemallow, rutabaga, ryegrass, safflower, St. Augustine grass, salal, salpiglossis, salsify, scarborough-lily, scarlet runner bean, sedum, sequoia, shallot, Shasta daisy, sicana, snapdragon, snowball, snowberry, snowdrop, snowflake, soapberry, spiderlily, spinach, spruce, squash, stock, strawberry, sugarberry, sweetpea, sweetpotato, sweet-william, sycamore, tanbark-oak, toadflax, tomato, tritonia, trumpetvine, tuberose, tulip, tupelo, turnip, udo, vegetable-marrow, viburnum, Virginia creeper, vinca, violet, wallflower, walnut, waterlily, watermelon, wheatgrass, willow, yam, yew, yucca, zephyranthes, zinnia, and zoysiagrass.

Control: Same as for (1) Fungus Leaf Spot. Prune trees and shrubs for better air circulation.

(4) Shot-hole Small spots on leaves of stone fruits and related plants which later drop out leaving typical shot-holes. In-

fected leaves often change color and drop prematurely. Young fruit may be spotted, deformed, and fall early. Sunken, reddish cankers may develop on the twigs. Fruit buds and fruiting wood may die during the winter. Shot-hole may be caused by bacteria, fungi, viruses, or spray injury. It is often a secondary symptom of fungus or bacterial leaf spot on many kinds of plants. See (1) Fungus Leaf Spot and (2) Bacterial Leaf Spot above.

Plants Attacked: Almond, apricot, cherry, cherry-laurel, flowering almond, flowering cherry, nectarine, peach, and plum.

Control: Same as for (1) Fungus Leaf Spot. Follow spray program for fruits in question as given in Table 10 in the Appendix. Collect and burn fallen leaves, where possible. Plant virus-free stock from a reliable nursery.

(5) Botrytis Blight, Gray-mold Blight, Bud Rot, Blossom Blight, Twig Blight Generally distributed. Soft, tan-colored to brown spots or blotches on leaves, stems, flowers, ripening fruit, tubers, or roots during or following cool, damp periods. Affected parts are often covered with a coarse, tan-nish-gray mold in damp weather. Seedlings or young shoots may wilt and collapse if attacked near the soil line. Buds may rot. Flowers may be distorted with irregular flecks or spots. Older flowers rot quickly. Common in greenhouses and cool, humid areas. See (31) Flower Blight and (32) Fruit Spot. The fungus enters through wounds, dying leaves, or old flower petals.

Plants Attacked: African-violet, alder, almond, amaryllis, Amazon-lily, anemone, apple, apricot, arborvitae, aristolochia, artemisia, artichoke, ash, asparagus, aster, aucuba, azalea, babysbreath, barberry, bean, beet, begonia, blackberry, blood-root, blueberry, blue cohosh, boysenberry, broccoli, Brussels sprouts, buttercup, cabbage, cacti, caladium, calendula, calla, camass, camellia, candytuft, cape-mari-gold, carnation, carrot, castorbean, cauliflower, celery, centuryplant, cherry, chicory, China-aster, Chinese hibiscus, chives, Christmas-rose, chrysanthemum, cigar-flower, cineraria, clarkia, colchicum, coleus, columbine, coralberry, cornflower aster, cotton-rose, cranesbill, cucumber, currant, cyclamen, dahlia, daphne, day-lily, delphinium, dewberry, dogwood, dogstooth-violet, Douglas-fir, dracaena, dusty-miller, Dutchmans-pipe, eggplant, endive, English daisy, escarole, eupatorium, European cranberry-bush, exacum,

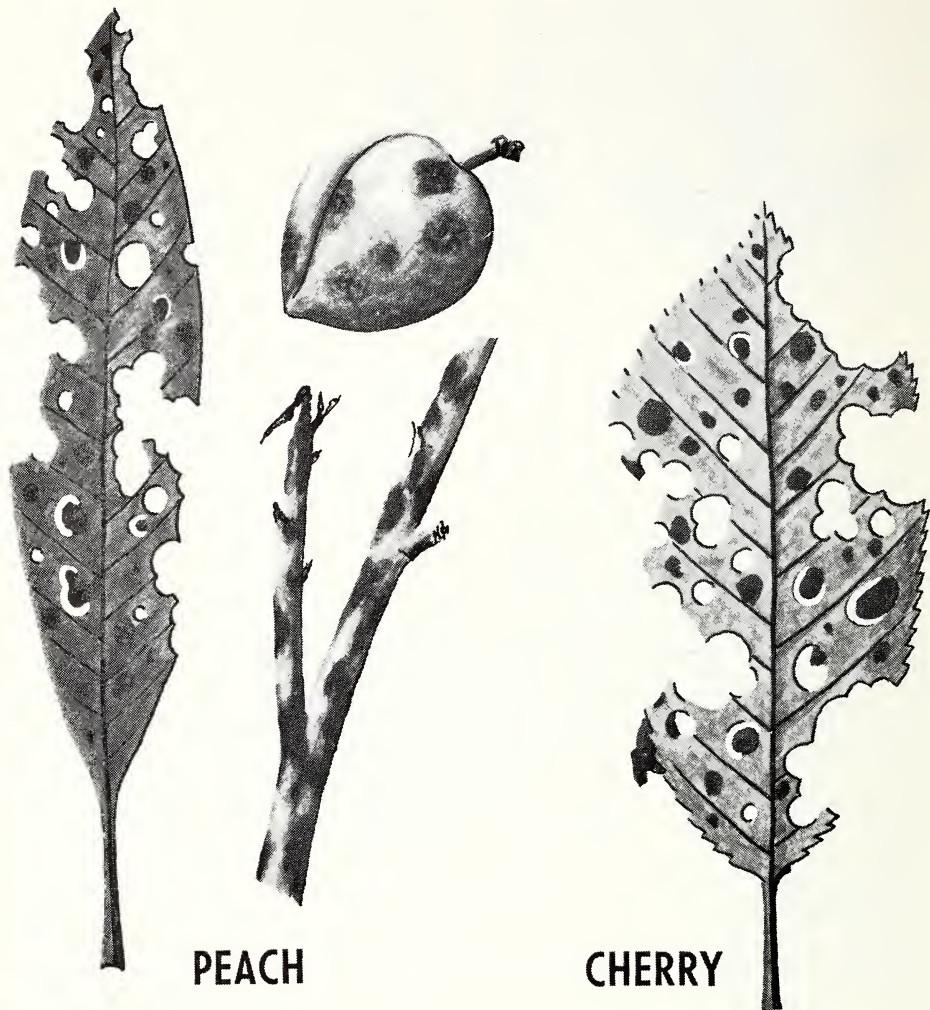


Fig. 18. Shot-hole of peach and cherry. These same leaf symptoms may be caused by various fungi, bacteria, viruses, or pesticide injury.

feijoa, fennel, fig, flax, flowering almond, flowering currant, forget-me-not, fuchsia, gardenia, garlic, gentian, geranium, gladiolus, globe-amaranth, globe artichoke, gloxinia, godetia, gooseberry, grape, gypsophila, hawthorn, heath, heliotrope, hemlock, honeysuckle, hyacinth, hydrangea, iris, ixia, Jack-in-the-pulpit, kale, kohlrabi, larch, leek, lentil, lettuce, lilac, lily, lily-of-the-valley, lobelia, lupine, Maltese cross, marigold, Mayapple, mertensia, mistflower, mockorange, narcissus, nasturtium, okra, onion, orchids, pansy, parsnip,

pea, peach, peanut, pear, peony, pepper, persimmon, petunia, phlox, pine, pinks, plantainlily, plum, poinsettia, pomegranate, poppy, potato, primrose, pumpkin, pyrethrum, quince, rape, raspberry, redwood, rhododendron, rhubarb, rockcress, rose, roselle, rose-of-Sharon, rutabaga, safflower, sea-lavender, sequoia, shallot, skullcap, snapdragon, snowberry, snowdrop, snow-on-the-mountain, spruce, squash, statice, stock, stokesia, strawberry, sunflower, sweetpea, sweetpotato, thimbleberry, tomato, tradescantia, Transvaal

daisy, tuberose, tulip, turnip, verbena, viburnum, vinca, violet, Virginia bluebell, wallflower, and zinnia.

Control: Cut and burn infected plants and plant parts, where practical. Carefully remove and burn fading flowers before petals fall. Avoid overcrowding, wet mulches, and shady or low spots with poor air circulation. Keep down weeds. Cure bulbs, corms, tubers, etc., rapidly at high temperatures before storing at the recommended temperature. Avoid high humidities indoors. Increase air circula-

tion and temperature. Keep water off the foliage when watering. Spray at 5-day intervals during cool, wet weather using captan, zineb, ferbam, thiram, maneb, chloranil, phaltan, dichlone, or a copper-containing fungicide. Take cuttings from healthy plants and propagate in a sterilized rooting medium. Spray flowers just before storage using zineb or captan ($\frac{2}{3}$ tablespoon per gallon).

(6) **Downy Mildew** Pale green or yellowish areas usually appear on the upper leaf surface with corresponding light gray,

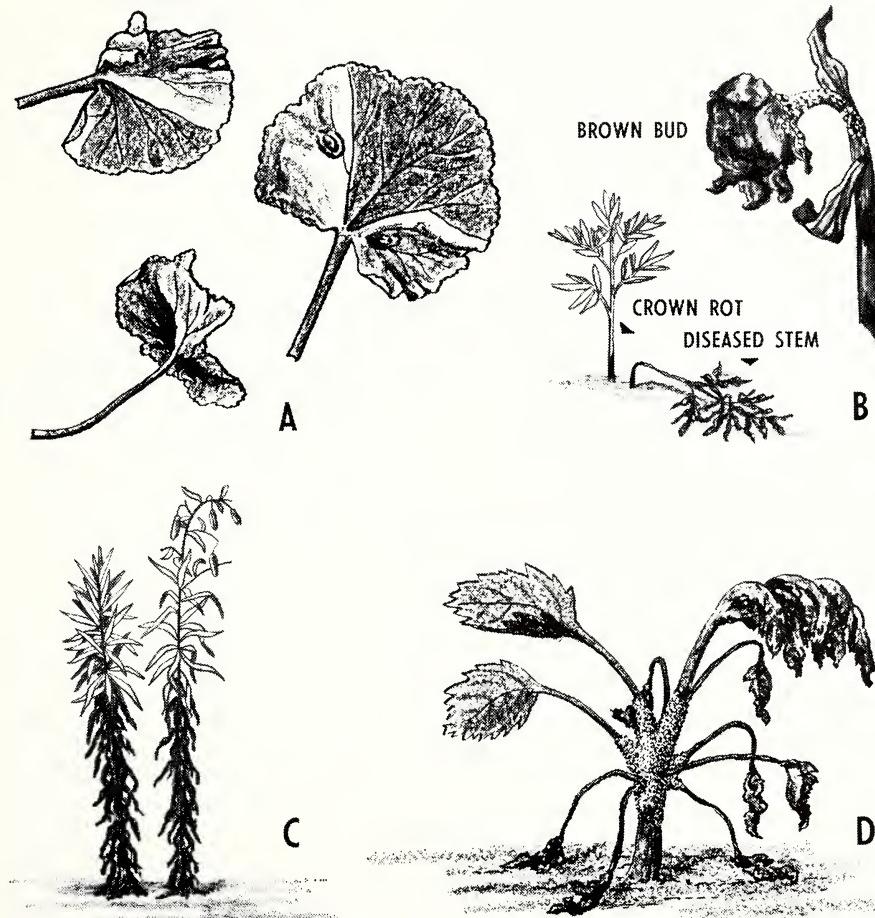


Fig. 19. Botrytis blight or gray-mold blight. A. Geranium, B. Peony, C. Lily, D. Aster.
Note gray mold on peony bud and aster stem.

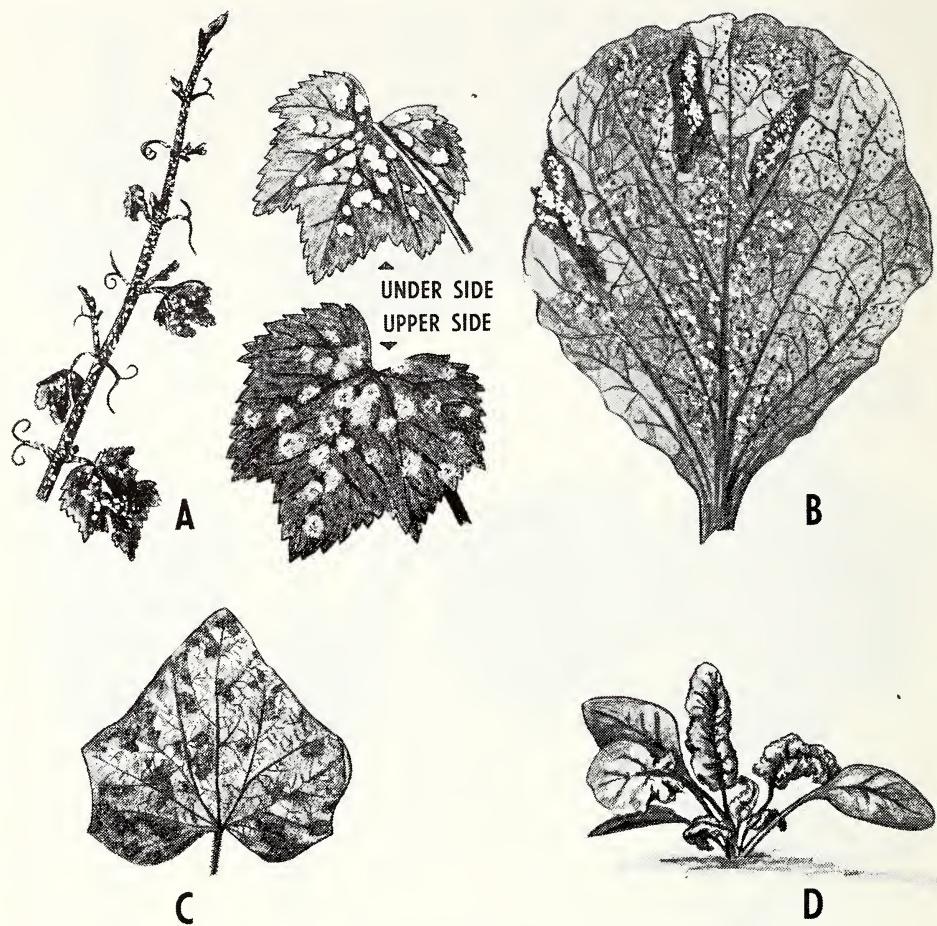


Fig. 20. Downy mildew. A. Grape, B. Lettuce, C. Cucumber, D. Spinach.

downy, or purplish patches of mildew below. Affected areas enlarge and turn yellow or brown. Leaves often wilt, wither, and die early. Stems, flowers, and fruits are sometimes infected. Seedlings may wilt and collapse. Attacks are most severe in cool, humid, or wet weather (warm days and cool nights).

Plants Attacked: Acalypha, ampelopsis, anemone, arrowwood, artemisia, artichoke, aster, avens, bachelors-button, balsam-apple, balsam-pear, bean, bedstraw, beet, Bermudagrass, blackberry, Boston ivy, boysenberry, broccoli, Brussels sprouts, bryonopsis, butter-and-eggs, buttercup, butternut, cabbage, caladium, candytuft,

cantaloup, carnation, carrot, cassaba, cauliflower, celery, celtuce, centaurea, chervil, chicory, China-aster, chinaberry, Chinese cabbage, Chinese waxgourd, chives, cineraria, citron, clarkia, collards, cornflower, cornflower aster, corydalis, cranesbill, crimson daisy, crownbeard, cucumber, currant, damesrocket, dewberry, dragon-head, Dutchmans-breeches, eggplant, endive, erysimum, escarole, eupatorium, European cranberry-bush, evening-primrose, everlasting flower, false-dragonhead, fennel, fleabane, flowering tobacco, forget-me-not, four-o'clock, gaillardia, garden cress, garlic, germander, gilia, godetia, goldenglow, gooseberry, gourds, grape,

hackberry, heronsbill, horse radish, houndstongue, houstonia, Jerusalem-artichoke, Joe-pye-weed, kale, kohlrabi, leek, lettuce, liverleaf, lupine, marigold, meadowrue, meconopsis, melothria, mertensia, mignonette, mock-cucumber, monkshood-vine, mullein, muskmelon, mustard, nicotiana, onion, pansy, parsley, parsnip, pea, pecan, pepper, peppergrass, phlox, physostegia, poppy, potentilla, prairie-coneflower, prickly-poppy, primrose, privet, pumpkin, radish, raspberry, redbud, rhubarb, rockcress, rockjasmine, rose, rudbeckia, rutabaga, salvia, sand-verbena, shallot, silene, silphium, snapdragon, snowberry, speedwell, spiderflower, spinach, squash, squirrelcorn, stock, strawberry, sugarberry, sunflower, sweet alyssum, sweetpea, Swiss chard, teasel, toadflax, tomato, toothwort, trailing four-o'clock, turnip, umbrellawort, verbena, viburnum, violet, Virginia creeper, wallflower, walnut, watermelon, wayfaring-tree, West Indian gherkin, whitlowgrass, and wild sweet-william.

Control: Practice a 2- to 3-year crop rotation. Collect and burn infected plant parts when first evident. Burn tops after harvest. Maintain a balanced soil fertility, based on a soil test. Use disease-free seed from healthy stock plants. Resistant varieties offer hope for some types. Avoid overcrowding and high humidities indoors and in the seedbed. Dust or spray at 5-day intervals in cool, wet weather using a zineb, maneb, chloranil, or copper-containing fungicide. Or follow the spray schedule outlined under plant in question.

(7) Powdery Mildew Superficial, white to light grayish, powdery coating or felt on leaves, buds, flowers, and young shoots. Affected plant parts may be dwarfed and curled. Leaves may yellow, wither, and die prematurely. Mildew spots often enlarge until they eventually cover the whole leaf. Common when cool nights follow warm days, in crowded low areas where air circulation is poor, or in damp, shaded locations. Powdery mildew is most common on many plants from mid-summer on.

Plants Attacked: Abelia, acacia, acalypha, acanthopanax, achillea, aconitum, African-violet, ageratum, alder, almond, amelanchier, amorpha, ampelopsis, anchusa, anemone, anoda, apple, apricot, aralia, arenaria, arnica, arrowwood, arte-

misia, artichoke, artillery-plant, ash, asparagus-bean, aster, astilbe, aucuba, avens, avocado, azalea, babytears vine, bachelors-button, balsam-apple, balsam-pear, balsamroot, barberry, basketflower, bean, bearberry, bedstraw, beech, beet, begonia, bellflower, Bermudagrass, betony, birch, bishopscap, bittersweet, blackberry, black locust, bladder-senna, blazing-star, blueberry, blue daisy, bluegrass, boltonia, Boston ivy, boxelder, boysenberry, broccoli, broom, buckthorn, buffaloberry, bur-marigold, burnet, buttercup, butterfly-flower, buttonbush, cabbage, calendula, California-poppy, California-rose, calycanthus, campanula, camphor-tree, candytuft, cantaloup, Canterbury-bells, cardoon, carnation, carrot, cassia, catalpa, cauliflower, centaurea, cherry, cherry-laurel, chestnut, chicory, China-aster, chinaberry, Chinese cabbage, chinquapin, chrysanthemum, cigarflower, cineraria, citron, clematis, collards, collomia, columbine, coralbells, coralberry, coreopsis, cornflower, cornsalad, cosmos, cotoneaster, cottonwood, crabapple, cranesbill, crappemyrtle, crimson daisy, crotalaria, crownbeard, cucumber, culversroot, currant, dahlia, delphinium, dewberry, dogwood, dusty-miller, dwarf cornel, eggplant, elder, elecampane, elm, endive, erysimum, euonymus, eupatorium, European cranberry-bush, evening-primrose, false-indigo, fescue grass, feverfew, filbert, filipendula, fleabane, flowering almond, flowering raspberry, flowering tobacco, foamflower, forestiera, forget-me-not, fringetree, fuchsia, gaillardia, gardenia, gaultheria, geranium, germander, gilia, globe artichoke, globemallow, glowing gold, golden-aster, goldenglow, gooseberry, gourds, grape, groundsel, hackberry, hardhack, hawksbeard, hawthorn, hazelnut, heath, heliopsis, heuchera, hickory, highbush cranberry, holly, hollyhock, holodiscus, honeylocust, honeysuckle, hop-hornbeam, hoptree, hornbeam, horse-chestnut, horseradish, houndstongue, huckleberry, hyacinth-bean, hydrangea, hypericum, indigo, indigobush, inula, Japanese pagodatree, Jerusalem-artichoke, Joe-pye-weed, kalanchoë, kale, kohlrabi, Labrador-tea, leopardsbane, lettuce, liatris, lilac, linden, lithospermum, locust, London plane, lupine, lyonia, magnolia, mallow, maple, marguerite, matricaria, matrimony-vine, Mayflower, meadowrue, meadowsweet, meconopsis, melothria, menziesia, mertensia, mint, mistflower.

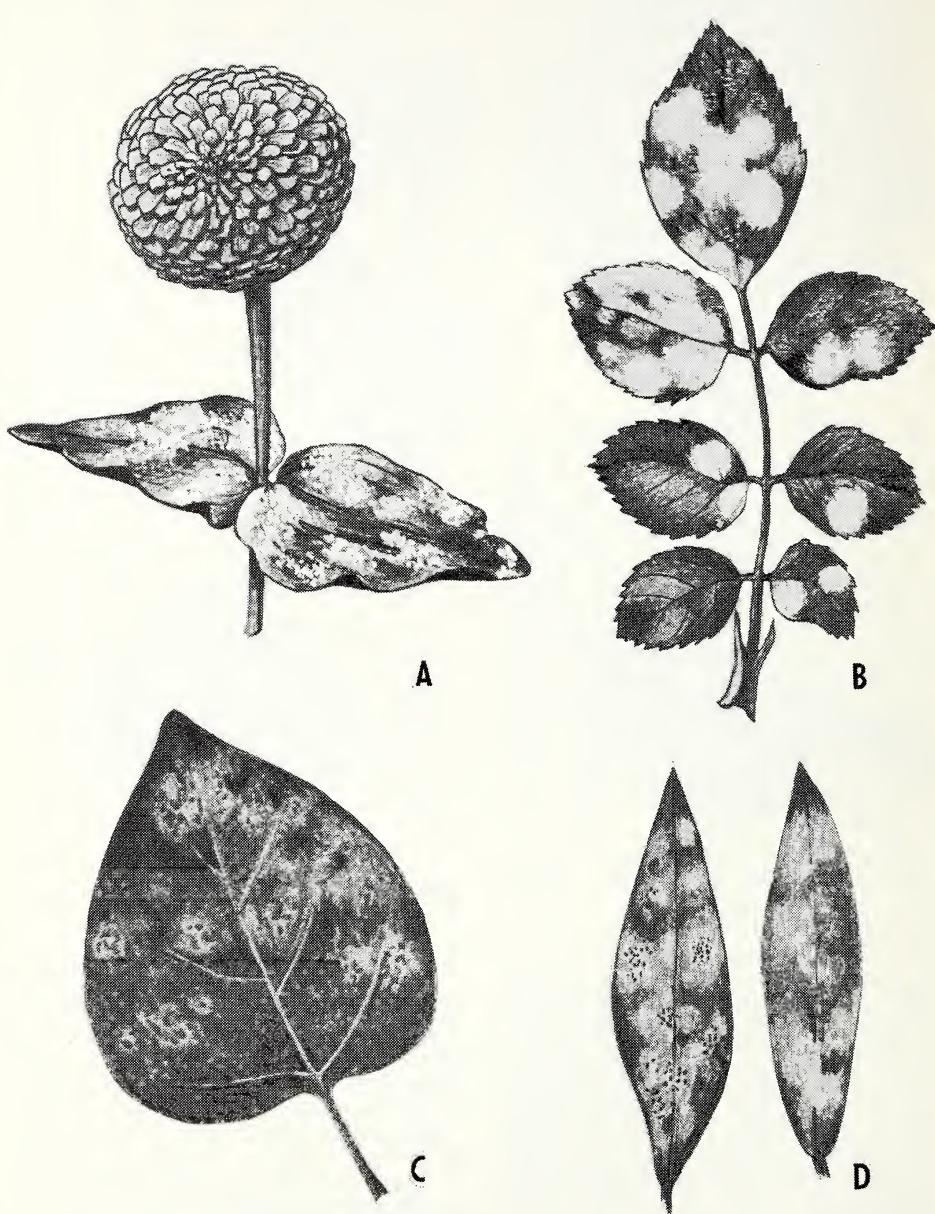


Fig. 21. Powdery mildew. A. Zinnia, B. Rose, C. Lilac, D. Phlox. The black specks in the left phlox leaf are the sexual fruiting bodies (cleistothecia) of the powdery mildew fungus. These are often produced on plants late in the growing season.

mitella, mock-cucumber, mockorange, monkeyflower, monkshood-vine, moonseed, mountain-ash, mountain-holly, mountain-laurel, mountain-mint, mulberry, mullein, muskmelon, mustard, myrtle, nectarine, nemophila, New Jersey-tea, nicotiana, ninebark, oak, okra, orange, osoberry, oxalis, painted-cup, painted-tongue, pansy, parsnip, pea, peach, pear, pecan, penstemon, peony, pepper, persimmon, petunia, phacelia, philibertia, phlox, photinia, piggy-back plant, piqueria, planetree, plum, plumed thistle, polemonium, poplar, poppy, potato, potentilla, prairie-coneflower, prickly-ash, primrose, privet, prunella, pumpkin, purple-flowered groundcherry, queen-of-the-prairie, quince, radish, rape, raspberry, rhododendron, rose, roselle, rose-moss, rudbeckia, rue-anemone, rutabaga, St.-Johns-wort, salal, salpiglossis, salsify, salvia, sandwort, sarsaparilla, sassafras, saxifrage, scabiosa, scarlet runner bean, senna, serviceberry, silphium, silverberry, silver king, skullcap, snapdragon, sneezeweed, snowball, snowberry, snow-on-the-mountain, soapberry, sophora, speedwell, spirea, spurge, squash, stachys, strawberry, sumac, sunflower, swede, sweet alyssum, sweetpea, sycamore, tamarisk, tansy, teasel, teapary bean, thermopsis, thistle, tickseed, tidytips, tomato, trailing-arbutus, trailing four-o'clock, Transvaal daisy, tree-tomato, trumpetvine, tuliptree, turnip, turtlehead, valerian, verbena, viburnum, violet, Virginia bluebell, Virginia-creeper, wallflower, walnut, watermelon, weigela, West Indian gherkin, wheatgrass, wild sweet-william, willow, winterberry, wisteria, witch-hazel, wolfberry, woodwaxen, yellow ironweed, yellowwood, and zinnia.

Control: Resistant varieties of certain flowers and vegetables are available. Avoid overcrowding and damp, shady locations. Indoors, increase air circulation and night temperature. Where needed, dust or spray several times, 7 to 10 days apart, using Karathane, sulfur, Acti-dione, or phaltan. Avoid applications when the temperature is 85° F. or above. Collect and burn affected leaves, stems, and other debris in the fall.

(8) Rust — Leaf, Stem, Needle Bright yellow, orange, orange-red, reddish-brown, chocolate-brown, or black powdery pustules. Some rusts have as many as five

different spore forms in a single season's life cycle which vary in size, shape, and color. Pustules are most common on the lower leaf surface and on stems. Leaves often wither and die early; plants may be stunted. When severe, they may even wilt and die (e.g., snapdragon).

True rusts are of two general types:

(a) Fungus completes life cycle on the same type of plant (autoecious or monoecious rusts). Examples: Asparagus, bean, beet, blackberry, carnation, chrysanthemum, hollyhock, pea, raspberry, rose, snapdragon, sunflower, Swiss chard, and violet.

(b) Fungus requires two different kinds of plants, (or an alternate host) to complete the life cycle. Such rusts are heteroecious. Examples:

1. *Juniper* or *redcedar* and apple, chokeberry, crabapple, quince, flowering quince, mountain-ash, hawthorn, photinia, amelanchier, squaw-apple, fendlera, mockorange, etc.
2. *Spruce* and bog-rosemary, creeping snowberry, Labrador-tea, pyrola, woodnymph, crowberry, rhododendron, etc.
3. *Pine* and bellflower, goldenrod, sunflower, moonflower, Jerusalem-artichoke, morning-glory, moonflower-vine, quamoclit, gaillardia, currant, gooseberry, blazing-star, marigold, senecio, China-aster, viburnum, Indian paintbrush, sweetfern, sweetgale, oak, buckleya, amsonia, sweetpotato, etc.
4. *Hemlock* and poplar, blueberry, azalea, rhododendron, menziesia, hydrangea, lyonia, etc.
5. *Douglas-fir* and poplar.
6. *Larch* and willow, poplar, or birch.
7. *Lupine* and spinach, garden cress, and radish.
8. *Currant* and *gooseberry* and *carex*, willow, etc.
9. *Wild grasses* and aconite, anemone, barberry, beet, buckthorn, California-bluebell, clematis, columbine, coralberry, delphinium, fleabane, four-o'clock, garden cress, heliotrope, Indiana paintbrush, meadowrue, mertensia, mint, primrose, queens-delight, radish, sand-

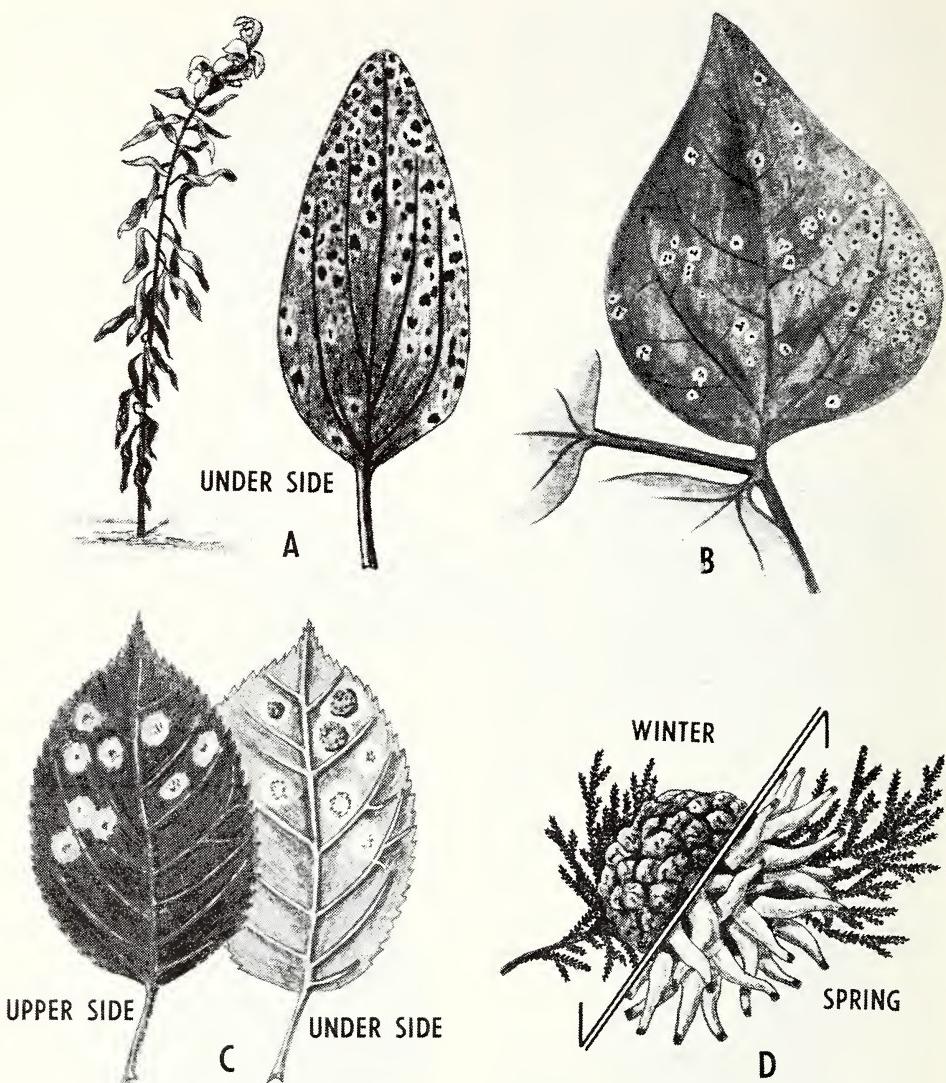


Fig. 22. Rust. A. Snapdragon, B. Bean, C. Apple, D. Juniper. The rust on juniper and apple (cedar-apple rust) are different disease symptoms caused by the same rust fungus.

verbena, snowberry, spiderflower, spinach, turtlehead, wolfberry, etc.

10. Corn and oxalis.
 11. Fir and ferns, willow, huckleberry, blueberry, chickweed, birch, etc.
- Rust on juniper and redcedar appears as reddish-brown, bean-shaped galls from which protrude a mass of orange, gelat-

inous tendrils during spring rains (Figure 22D).

Plants Attacked: Abutilon, acacia, acanthopanax, achillea, aconitum, ageratum, alder, allium, almond, amelanchier, American spikenard, amorphia, ampelopsis, anemone, anchusa, angelica, anise, anise-root, anoda, apple, apricot, aralia,

arbutus, arenaria, armeria, arnica, arrowwood, artemisia, ash, asparagus, aster, atamasco-lily, avens, azalea, babysbreath, baby tears vine, bachelors-button, balsamroot, baneberry, barberry, bayberry, bean, bearberry, bedstraw, beet, bellflower, bellwort, bentgrass, Bermudagrass, birch, bishopscap, blackberry, black gum, bladder-senna, blazing-star, blueberry, blue-eyed grass, bluegrass, boisduvalia, boltonia, bouvardia, boysenberry, brodiaea, broom, buckthorn, buffaloberry, buffalograss, bur-marigold, burnet, buttercup, butterflyweed, buttonbush, caesalpinia, calendula, California-bluebell, California-rose, calochortus, campion, canna, Canterbury-bells, cape-marigold, cardinal climber, carnation, carpetgrass, carrot, centaurea, chamaecyparis, chamaedaphne, checkermallow, cherry, chicory, China-aster, Chinese lanternplant, chives, chokeberry, chrysanthemum, chuperosa, cimicifuga, cissus, clarkia, clematis, coffeeberry, collinsia, collomia, columbine, columbo, coralbells, coralberry, corn, cornel, cornflower, corydalis, cosmos, cottonwood, cowania, crabapple, cranesbill, crimson daisy, crownbeard, culversroot, cunila, currant, cypress, cypress-vine, dayflower, delphinium, desertplume, dewberry, dit-tany, Douglas-fir, dogwood, dogstooth-violet, Dutchmans-breeches, dwarf cornel, dyschoriste, echeveria, eggplant, elder, elecampane, emilia, encelia, endive, erysimum, eupatorium, evening-primrose, false-dragonhead, false-garlic, false-indigo, false-mesquite, fendlera, ferns, fescue grass, fig, fir, flax, fleabane, filipendula, Florida yellowtrumpet, flowering currant, flowering quince, flowering raspberry, foamflower, forestiera, forget-me-not, four-o'clock, frangipani, fritillaria, fuchsia, gaillardia, garden cress, garlic, gentian, geranium, germander, giant night white bloomer, gilia, globemallow, godetia, golden-aster, goldenglow, gooseberry, grape, groundcherry, ground-pink, groundsel, harebell, hawksbeard, hawthorn, hearts and honey vine, heath, heliopsis, heliotrope, hemlock, hen-and-chickens, Hercules-club, heuchera, hibiscus, holly, hollyhock, honeylocust, honeysuckle, hophornbeam, hop-tree, horsechestnut, houseleek, houstonia, huckleberry, hyacinth, hydrangea, hypericum, incense-cedar, indigobush, iris, Jack-in-the-pulpit, jacquemontia, Jerusalem-artichoke, Joe-pye-weed, juniper, kochia, Labrador-tea, lantana, larch, lava-

tera, leadtree, leatherwood, leek, leonotis, lettuce, liatris, lily, lithospermum, liverleaf, lobelia, locust, loosestrife, lupine, lyonia, madrone, mahonia, malacothrix, mallow, Maltese cross, malvastrum, manfreda, mangold, manzanita, maranta, marbleseed, marigold, matricaria, matrimony-vine, mayapple, meadowrue, meadow-sweet, mentzelia, menziesia, mertensia, mistflower, mitella, mockorange, monarda, monardella, monkeyflower, monkshood, moonflower, morning-glory, mountain-ash, mustard, nasturtium, New Jersey-tea, oak, okra, onion, orchids, Oregon-grape, Osage-orange, osier, oxalis, painted-cup, pansy, pea, peach, peanut, pear, pearl everlasting, penstemon, peppergrass, petunia, phacelia, philibertia, phlox, photinia, physostegia, pine, pinks, plum, plumed thistle, poinciana, poinsettia, polemonium, polygala, poplar, poppy-mallow, potentilla, prairie-coneflower, primrose, prickly-ash, prickly-poppy, prune, quamoclit, queen-of-the-prairie, queens-delight, quince, radish, rainlily, raspberry, redcedar, redbud, rhododendron, rhubarb, rockcress, rock-jasmine, romanoffia, rose, rosemallow, rose-of-Sharon, rougeplant, rudbeckia, rue-anemone, ruellia, Russian-olive, ryegrass, safflower, St.-Andrews-cross, St. Augustine grass, St.-Johns-wort, salsify, salvia, sandverbena, sarsaparilla, satin-flower, saxifrage, scarlet runner bean, sea-lavender, sedum, sensitive plant, shallot, shooting-star, sida, sidalcea, silphium, silverberry, silver king, silver lacevine, smelowskia, smoke-tree, snapdragon, sneezeweed, snowberry, snow-on-the-mountain, sophora, southern leatherwood, speedwell, spider-flower, spinach, spruce, spurge, stanleya, stachys, statice, stenanthium, sumac, sunflower, sweetfern, sweetgale, sweet-jarvill, sweetpea, sweetpotato, sweet-william, Swiss chard, synthyris, taenidia, tamarack, tanbark-oak, tansy, teapary bean, thimbleberry, thistle, tickseed, toadflax, toothwort, tradescantia, trailing four-o'clock, trillium, trumpet-tree, tupelo, turtlehead, valerian, venus-lookingglass, verbena, viburnum, vinca, violet, watercress, waxmyrtle, wheatgrass, white-cedar, whitlowgrass, wild sweet-william, willow, wirelettuce, wolfberry, woodwaxen, wyethia, yellow-cedar, yellow ironweed, yerba-buena, yucca, zauschneria, and zephyranthes.

Control: If possible, destroy nearby alternate host plants, especially weeds which show rust. A distance of several hundred

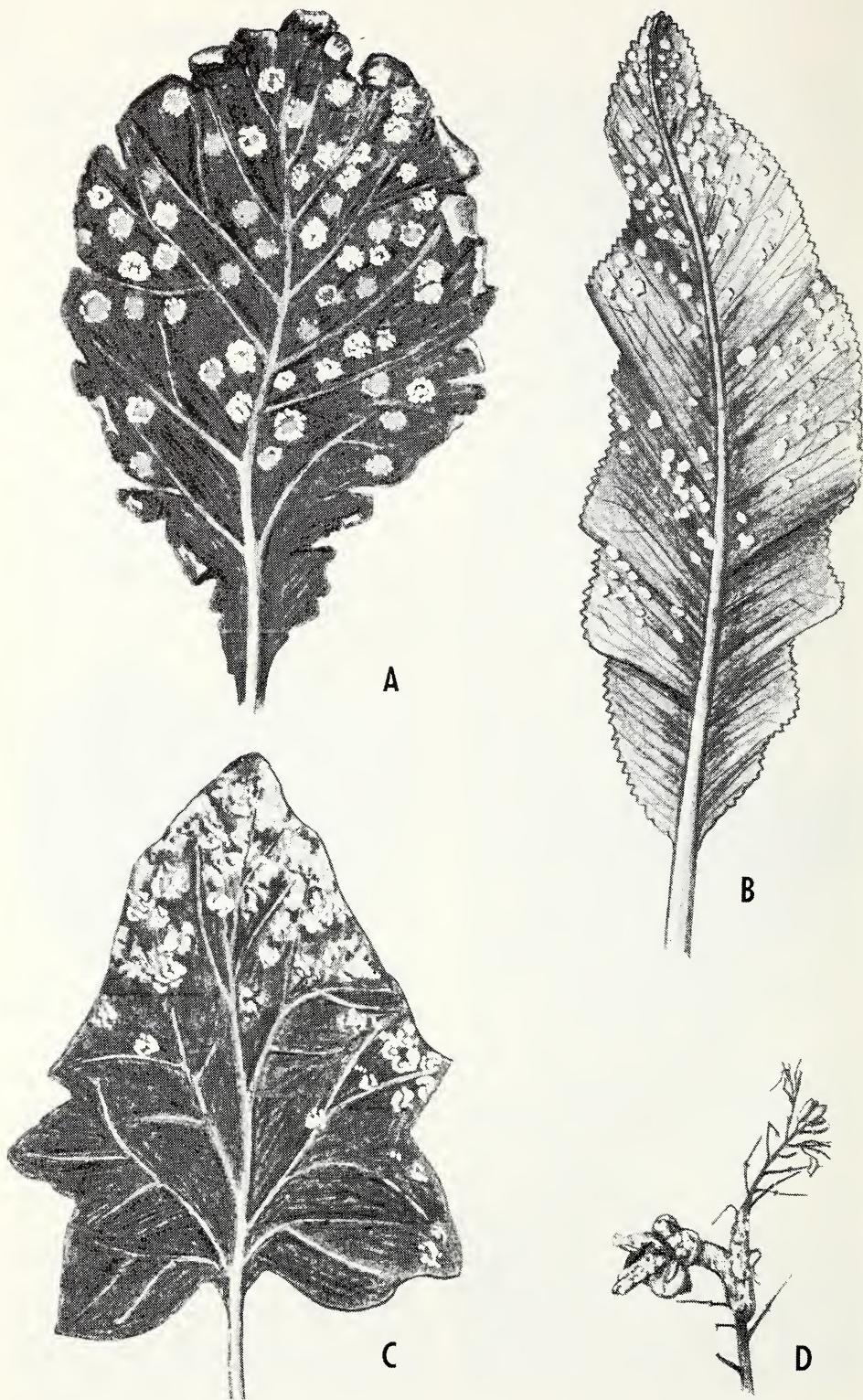


Fig. 23. White-rust. A. Cabbage, B. Horseradish, C. Spinach, D. Radish with aborted flower parts.

yards between alternate hosts, or more, is usually necessary for some measure of control. Collect and burn infected plant parts when first seen. Follow a spray program for fruits (see Table 10 in the Appendix) and certain flowers. Dust or spray with ferbam, zineb, maneb, or sulfur. Prune out and burn infected tree branches showing rust cankers, galls, spindle-shaped swellings, or witches'-brooms. Use resistant varieties or species when available. Plant only healthy stock. Where rust is perennial in roots (e.g., orange rust of bramble fruits), destroy plants before pustules appear in the spring. Indoors, raise the temperature, reduce air humidity, and keep water off the foliage.

(9) White-Rust, White Blister Pale yellow areas develop on the upper leaf surface with whitish pustules which may turn pale yellow with age forming on the corresponding underside of the leaves. The yellowish areas later turn brown and infections may spread to stems and flowers causing malformation and abortion. Leaves may eventually die and plants are dwarfed.

The white rusts are not related to the true rusts above.

Plants Attacked: Alternanthera, alyssum, amaranth, antennaria, artemisia, bachelors-button, beet, black-salsify, broccoli, Brussels sprouts, cabbage, California-rose, candytuft, cardinal climber, cauliflower, centaurea, Chinese cabbage, cornflower, cypressvine, damesrocket, erysimum, eupatorium, false-camomile, feverfew, four-o'clock, froelichia, garden cress, giant night white bloomer, globe-amaranth, groundsel, hearts and honey vine, horse-chestnut, horseradish, jacquemontia, kale, lettuce, matricaria, moonflower, morning-glory, mustard, parsnip, peppergrass, plumed thistle, quamoclit, radish, rockcress, rose-moss, rutabaga, salsify, scurvy-weed, spinach, stock, sunflower, sweet alyssum, sweetpotato, thistle, toothwort, trailing four-o'clock, turnip, umbrella-wort, wallflower, watercress, and whitlow-grass.

Control: Collect and burn infected plant parts. Destroy tops after harvest. Destroy nearby cruciferous weeds such as mustards, lambsquarters, and pigweed. Spray plants several times, 10 to 14 days apart, with maneb or a copper-containing fungicide.

(10) Leaf Curl or Gall, Leaf Blister, Witches'-broom, Plum Pockets Conspicuous white, yellow, red, brown, or gray "blisters" on leaves. Leaves may become puffy, puckered, thickened, and curled. Tend to drop early. Often fail to set fruit. Young peach fruit may be distorted and cracked. Plum fruits turn into enlarged swollen "bladders." Witches'-brooms (brushlike development of many weak shoots arising at or close to the same point) occur on *cherry*, *plum*, *alder*, *birch*, *California buckeye*, and *rhododendron* stems.

Plants Attacked: Alder, almond, amelanchier, apricot, azalea, bearberry, birch, blueberry, box sandmyrtle, buckeye, camellia, cassiope, catalpa, chamaedaphne, cherry, cherry-laurel, chinquapin, cottonwood, elm, ferns, filbert, flowering cherry, hazelnut, hophornbeam, hornbeam, huckleberry, lyonia, madrone, maple, nectarine, oak, peach, plum, poplar, rhododendron, sumac, and willow.

Control: Prune trees to increase air circulation. Remove witches'-brooms. Apply a single dormant spray to stone fruit trees before buds "break open" in the spring. Then follow the regular spray program during the season. See Table 10 in the Appendix and under the plant involved.

(11) Smut — Leaf, Stem, Anther, and Seed Dark brown to black, sooty, spore masses formed inside swollen, whitish blisters or galls. Appear on leaves, stems, bulbs, flower parts, and seed. Affected parts may wither and die. Plants may be stunted. Many smut-producing fungi enter plants in the seedling stage and develop systemically within the plant as it grows. The smut may not be evident externally until near maturity. Other smuts (e.g., corn and violet) are localized and any actively growing tissue (shoots, leaves, tassels, young ears, roots) may become infected. See (13) White Smut.

Plants Attacked: Aconitum, anemone, arenaria, avens, baneberry, bentgrass, Bermudagrass, bloodleaf, bluegrass, buffalo-grass, buttercup, camass, campion, carnation, chicory, chives, cissus, clematis, colchicum, columbine, coralbells, corn, cushion-pink, delphinium, dianthus, dog-tooth-violet, ferns, fescue grass, fig, garlic, gilia, gladiolus, globe-flower, grape-hyacinth, hepatica, heuchera, leek, liverleaf, lupine, Maltese cross, meadowrue, menziesia, monkshood, onion, oxalis, pansy, plumed thistle, redtop, rue-anemone, rye-

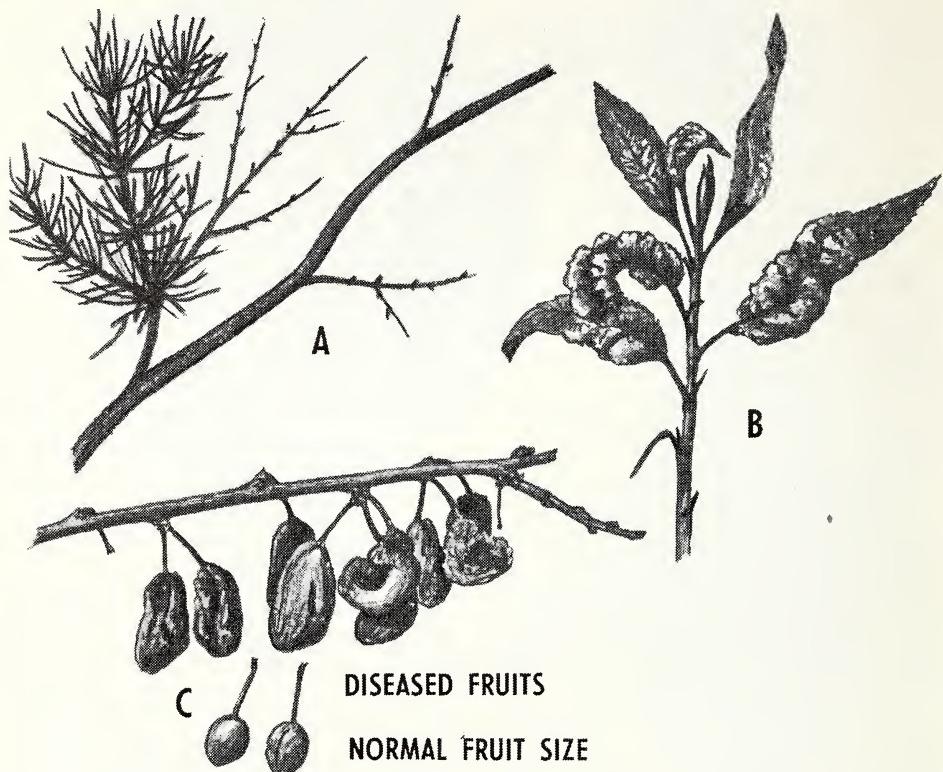


Fig. 24. A. Witches'-broom of cherry. B. Peach leaf curl. C. Plum pockets. These diseases are all caused by very closely related fungi.

grass, shallot, silver lacevine, speedwell, spurge, squill, sweet-william, thistle, trillium, venus-lookingglass, violet, and wheatgrass.

Control: Pick off and burn infected parts before blisters open. Use disease-free transplants. Treat seed or plant resistant varieties, where available. See plant in question and Table 13 in the Appendix.

(12) Sooty Mold or Blotch, Black Mildew
Unsightly, superficial, dark brown or black blotches or coating on leaves, fruit, and stems. Can be removed easily by rubbing. Fungus usually grows on "honeydew" excretions made by insects (e.g., aphids, scales, whiteflies, and others) or in flowing sap. Causes little if any damage to most plants. Subtropical plants, however, are sometimes permanently disfigured.

Plants Attacked: Alder, American blad-

dernut, anisetree, apple, arborvitae, ash, avocado, azalea, bearberry, beech, big-nonia, blackberry, blueberry, boxelder, buckthorn, buckwheat-tree, cacti, calendula, California-laurel, callicarpa, camellia, camphor-tree, catalpa, Carolina jessamine, chinaberry, cimicifuga, clematis, coffeeberry, columbo, confederate-jasmine, cottonwood, crabapple, crapemyrtle, daphne, dewberry, dogwood, elm, English ivy, ferns, fig, fir, franklin-tree, gardenia, gaultheria, grapefruit, hawthorn, hazelnut, holly, huckleberry, hyacinth-bean, ice-plant, inkberry, juniper, lantana, leatherwood, lemon, lemon-verbena, leucothoë, lily, linden, lippia, lyonia, magnolia, manzanita, maple, meconopsis, mockorange, oak, oleander, olive, onion, orange, osmanthus, palms, pansy, parkinsonia, partridge-berry, peach, pear, persimmon, philodendron, pine, plum, prickly-ash,

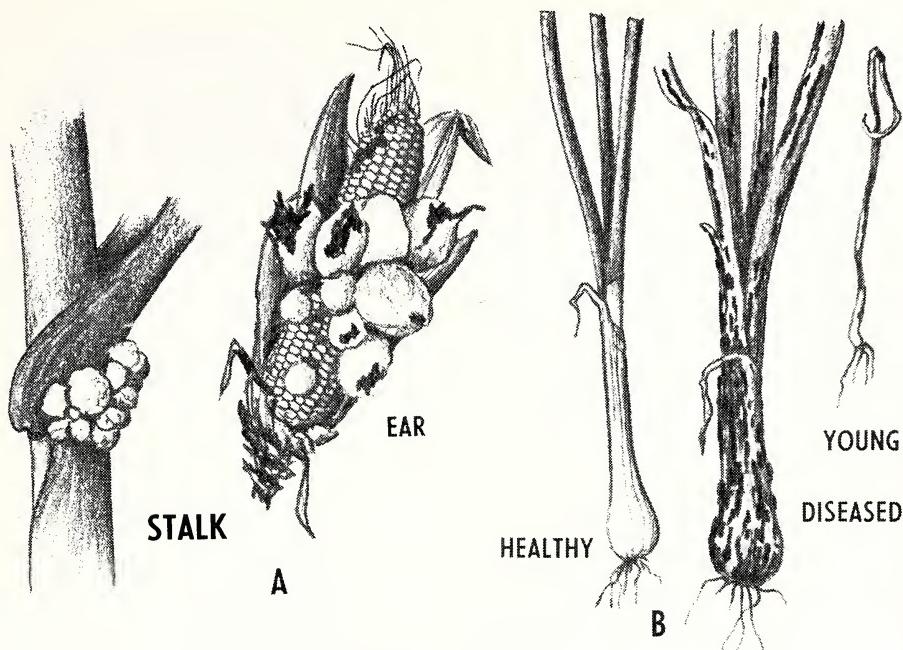


Fig. 25. Smut. A. Corn, B. Onion.

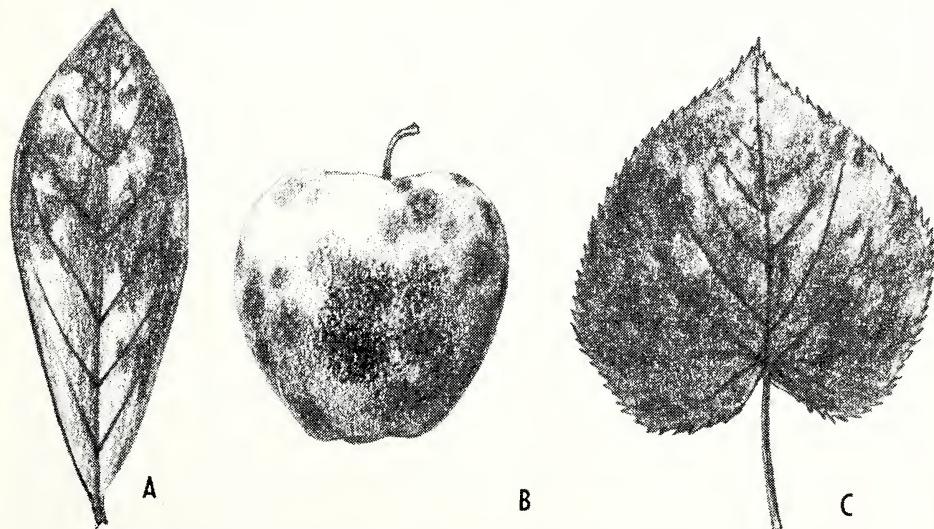


Fig. 26. Sooty mold on A. Magnolia, B. Apple, C. Basswood or Linden.

privet, redbay, redcedar, rhododendron, salal, sassafras, serviceberry, swampbay, sweetpotato, sycamore, tasseltree, tree-of-Heaven, tuliptree, twinflower, violet, wax-myrtle, willow, wintergreen, and yaupon. **Control:** Control insects by applying dusts or sprays containing malathion plus lindane, DDT, or methoxychlor. Check with your county agent, extension entomologist, florist, or nurseryman for the latest information on insecticides. Follow the spray schedules for fruit given in Table 10 in the Appendix. Avoid wounds. Paint injured areas promptly with a tree wound dressing (page 25).

(13) White Smut, Leaf Smut Pale, colorless, white, yellowish to yellowish-green leaf spots, which later turn a dark brown to black. Spots may sometimes drop out

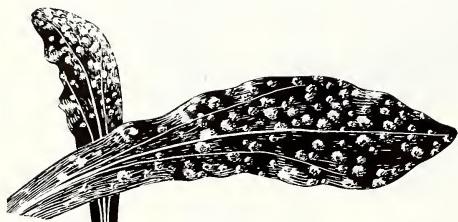


Fig. 27. White smut on calendula.

leaving ragged holes. Usually a minor problem. Disease is apparently favored in some cases by acid soils and late planting. See also (11) Smut.

Plants Attacked: Anemone, arnica, aster, bentgrass, bluegrass, boltonia, buttercup, butter-and-eggs, calendula, California-poppy, Chinese lanternplant, collinsia, crimson daisy, dahlia, delphinium, eryngium, eupatorium, firewheel, fleabane, gillardia, goldenglow, groundcherry, groundsel, lobelia, meadowrue, mertensia, moonseed, pondlily, poppy, prairie-coneflower, redtop, rudbeckia, senecio, silphium, sneezeweed, speedwell, spinach, sunflower, treepoppy, Virginia bluebell, waterlily, and wood anemone.

Control: Collect and burn diseased parts as they appear and burn plant debris after harvest. Spray with captan or a copper-containing fungicide at about 7- to 10-day intervals. Follow recommended cultural practices.

(14) Scab Symptoms variable depending on plant. Usually appears as roughened, crustlike (often raised or sunken) areas

on the surface of leaves, stem, fruit, root, tuber, or corm. Leaves may wither and drop early. Twigs often die back (willow). Caused by a few bacteria and a wide range of fungi. Easily confused with certain leaf or fruit spots and blights. See (1) Fungus Leaf Spot, (3) Leaf Blight, and (32) Fruit Spot and Rot.

Plants Attacked: Almond, apple, apricot, avocado, beet, cabbage, camphor-tree, cantaloup, carrot, cassaba, cherry, citron, cotoneaster, crabapple, crocus, cucumber, dahlia, eggplant, English ivy, euonymus, flowering cherry, freesia, gladiolus, gherkin, gooseberry, grapefruit, guava, hardy orange, hawthorn, Hercules-club, hickory, honeydew melon, iris, jasmine, lemon, lima bean, lime, loquat, mangel, mountain-ash, muskmelon, nectarine, oleander, onion, orange, palms, pansy, parsnip, pea, peach, pear, pecan, persimmon, photinia, plum, poinsettia, poplar, potato, pumpkin, pyracantha, quince, radish, rape, rutabaga, salsify, snowberry, spinach, squash, sweet-potato, Swiss chard, tickseed, tigerflower, turnip, violet, walnut, watermelon, and willow.

Control:

A. For root crops — Use resistant varieties. Use disease-free tubers (potatoes). Acidify the soil (to about pH 4.5) where practical. Avoid liming, applications of wood ashes, other alkaline materials, or barnyard manure. Practice a long crop rotation with nonsusceptible crops. Fertilize liberally. Keep down weeds. Turn under a green manure crop (page 16) where practical.

B. For other vegetables — Long crop rotation. Treat seed (see Table 13 in the Appendix); plant resistant varieties; spray plants with zineb, maneb, ziram, or captan.

C. For fruits and trees — Use resistant varieties if available. Remove and destroy dead twigs and branches and rotted fruit in the dormant season. Follow the spray program (Appendix, Table 14) using captan, sulfur, zineb, or other fungicide.

D. Flowers — Sanitation. Spray as for vegetables. Plant disease-free corms, tubers, bulbs, etc. See Table 13 in the Appendix.

(15) Wilts Wilting is due to a temporary or permanent deficiency of water in the foliage. Wilt diseases (causing permanent wilt) are easily confused with root rots, crown rots, stem cankers, grub or borer

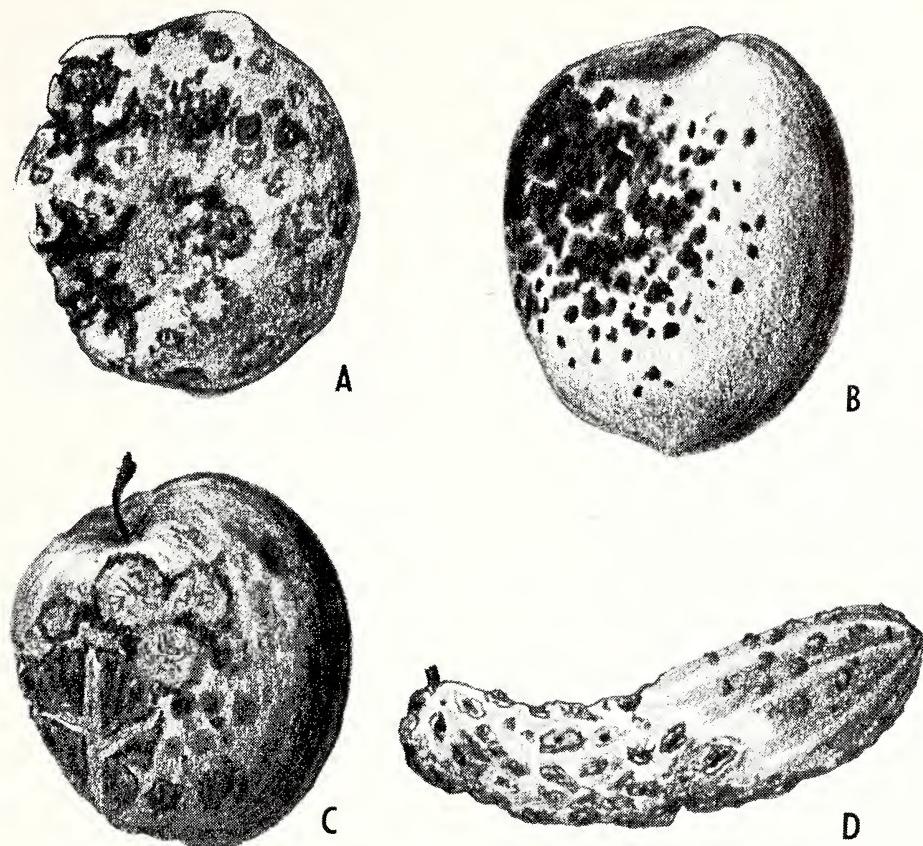


Fig. 28. Scab. A. Potato, B. Peach, C. Apple, D. Cucumber. The name scab is given to diseases caused by entirely different organisms. Control measures also vary greatly.

injury, drought, baking or compacting of the soil, etc. The over-all result is the same in all cases — a wilting, withering, and dying of the foliage *beyond* the point of injury. Only by close observation and experience can you determine the true cause. See under Stem and Root Diseases. Sprays or dusts are ineffective in controlling wilts.

There are three common types of wilts which may look identical, but are caused by altogether different organisms. These are Fusarium Wilt, Verticillium Wilt, and Bacterial Wilt. Wilt-producing fungi and bacteria invade the water and food-conducting vessels (vascular system) inside the stems and roots. The vessels become plugged and killed or become nonfunctional. The normal flow of liquids from

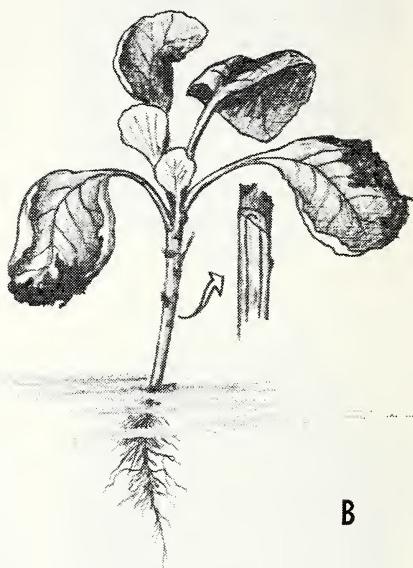
the roots to the foliage is greatly decreased or stopped altogether. Wilting of infected branches then follows.

Cutting into infected stems or branches commonly shows discolored streaks. Some plants die quickly from wilts; others may withstand attack for months or even years. For wilts which attack only a few plants, like Oak Wilt and Dutch elm disease, see under the plant involved.

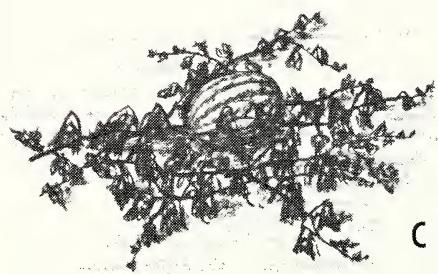
A. Fusarium Wilt or Yellows Plants are usually stunted and yellow. Disease symptoms often start at the base of the stem and progress upwards causing the leaves and flower heads to wilt and die. The lower parts of the stem (inside always, outside sometimes) are dark and discolored. When stems are cut lengthwise, brown to black streaks are evident



A



B



C



D

Fig. 29. Fusarium wilt. A. Tomato, B. Cabbage (often called cabbage yellows), C. Watermelon, D. Aster. The inside of diseased stems shows dark streaks when cut (see cabbage insert) where the fusarium fungus causes a partial to complete stoppage of liquids in the water-conducting tissue.

inside. Infected seedlings wilt and collapse. See (21) Crown Rot. Nematodes often provide wounds by which the *Fusarium* fungus may enter the roots.

Plants Attacked: Alternanthera, asparagus, asparagus-fern, astilbe, bachelors-button, bean, beet, bleedingheart, broccoli, browallia, Brussels sprouts, cabbage, cacti, cantaloup, cape-marigold, carnation, carrot, cassaba, catnip, cauliflower, celery, centaurea, China-aster, chrysanthemum, cineraria, citron, clarkia, collards, coriander, cornflower, cosmos, crotalaria, cucumber, cyclamen, dahlia, daphne, delphinium, dill, eggplant, eupatorium, fig, foxglove, freesia, garlic, gladiolus, groundsel, hebe, kale, kohlrabi, lantana, leek, marigold, "mimosa" tree, mock-cucumber, morning-glory, muskmelon, mustard, okra, orchids, painted-tongue, pansy, parsley, pea, peanut, pepper, petunia, poinsettia, polemonium, potato, pumpkin, radish, rutabaga, seakale, sedum, "smilax," snapdragon, speedwell, spinach, squash, stock, sumac, sweetpea, sweetpotato, sweet-wil-liam, tomato, turnip, watermelon, and zinnia.

Control: Use resistant varieties if available: Aster, bean, cabbage, carnation, "mimosa" tree, muskmelon, pea, sweetpea, tomato, and watermelon. Treat seed or plant in disinfested soil (see tables 13 and 14 in the Appendix). Collect and burn infected plants. Practice a long crop rotation excluding members of the same plant family. Fertilize and water to encourage vigorous growth.

B. *Verticillium* Wilt Leaves turn yellow and usually fall first from the lower part of the plant then the falling of the leaves progresses to higher parts of the plant. Infected trees and shrubs show one or more wilted branches with severe dropping of leaves from midsummer on. Annual plants and young trees are often stunted, wilt, and usually die. Perennials may be killed or recover. Twigs and branches often die back. The internal wood tissues of infected stems show dark streaks (greenish, gray, yellowish-brown, brown, bluish-brown, purplish, or black) when cut lengthwise. *Verticillium* Wilt is more prevalent in cooler climates and at lower soil temperatures than *Fusarium* Wilt. Infections often occur through wounds.

Plants Attacked: Abutilon, acanthopanax, aconitum, almond, American spikenard, apricot, aralia, artichoke, ash, asparagus, aspen, aster, aucuba, avocado, azalea, bachelors-button, balsam, barberry, bean, beech, beet, begonia, blackberry, black gum, black locust, blazing-star, boxelder, boysenberry, broccoli, Brussels sprouts, cabbage, calceolaria, California-poppy, camphor-tree, cantaloup, cape-marigold, carnation, cassaba, castorbean, catalpa, cauliflower, celery, centaurea, chayote, cherry, cherry-laurel, chicory, China-aster, chinaberry, Chinese lanternplant, chives, chrysanthemum, cineraria, citron, clarkia, coleus, collards, cornflower, crimson daisy, crown-of-thorns, cucumber, currant, dahlia, damesrocket, daphne, delphinium, dewberry, dogwood, eggplant, elder, elm, endive, erythrina, fleabane, foxglove, fremontia, fuchsia, garlic, geranium, goldenrain-tree, grape, groundsel, heath, heliotrope, honeylocust, horsechestnut, horseradish, Jerusalem-cherry, kale, Kentucky coffeetree, kohlrabi, leek, lettuce, liatris, lilac, linden, locust, magnolia, maple, marguerite, marigold, mignonette, mint, monkshood, muskmelon, mustard, New Zealand spinach, oak, okra, onion, Osage-orange, painted-tongue, parsley, pea, peach, peanut, peony, pepper, peppertree, persimmon, petunia, phlox, pittosporum, plum, polemonium, poplar, poppy, poppy-mallow, potato, privet, prune, pumpkin, quince, radish, raspberry, redbud, rhubarb, rose, Russian-olive, rudbeckia, rutabaga, safflower, salsify, sassafras, scarlet eggplant, smoketree, snapdragon, snowball, spinach, squash, stock, strawberry, strawflower, sumac, sunflower, sweetpea, sweetpotato, tickseed, Transvaal daisy, tuliptree, tomato, tree-of-Heaven, trumpetvine, turnip, udo, vegetable-marrow, viburnum, walnut, watermelon, wayfaring-tree, wildbergamot, and yellowwood.

Control: Dig up and burn infected flower, small fruit, and vegetable plants. Propagate from disease-free plants or use disease-free seed. Plant in clean or sterilized soil (pages 437-44) which is well-drained. Control soil insects using aldrin, dieldrin, chlordane, etc. Practice a long crop rotation with nonrelated crops. Keep down weeds. Fertilize and water to encourage vigorous growth. Varieties of

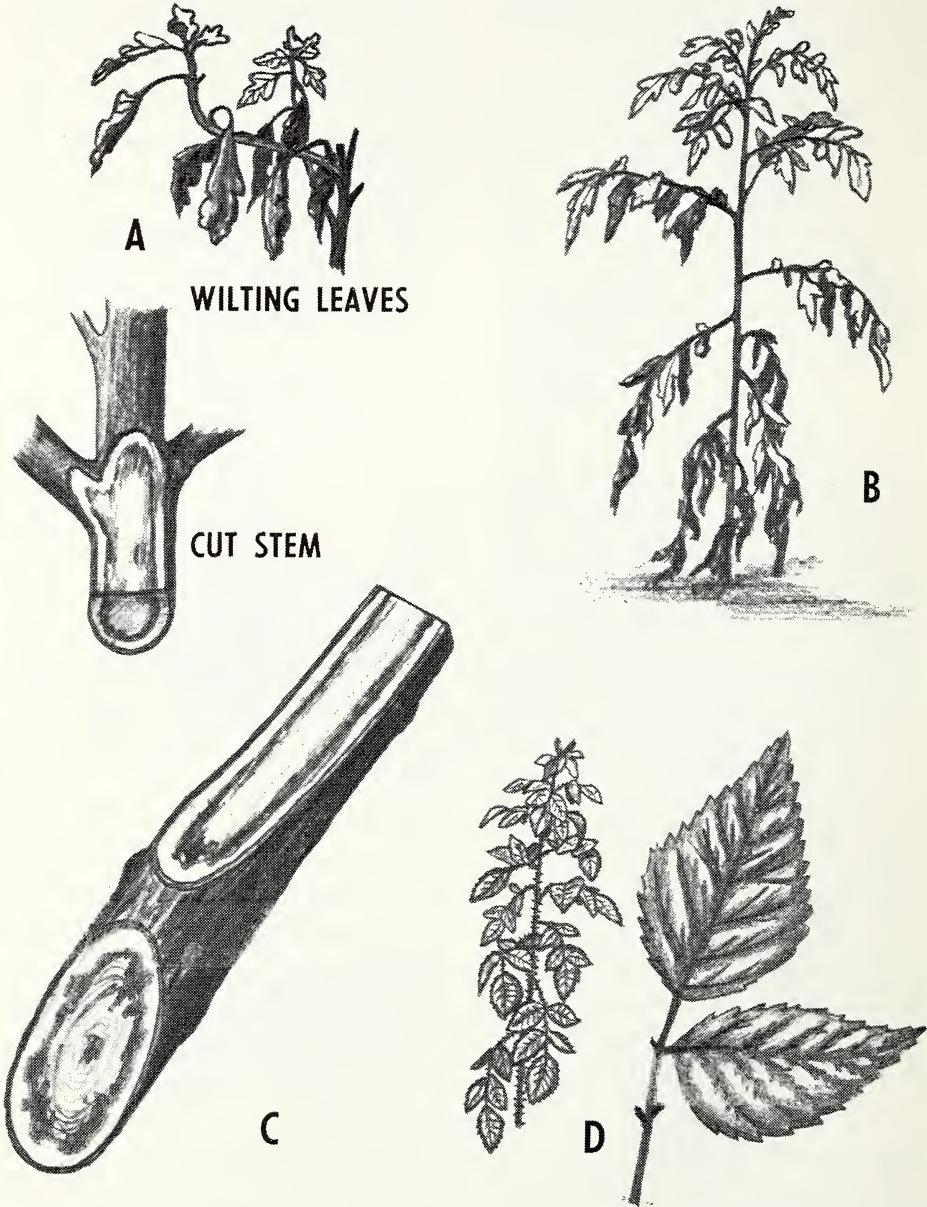


Fig. 30. Verticillium wilt. A. Eggplant, B. Tomato, C. Maple, D. Raspberry. Like *Fusarium*, the *Verticillium* wilt fungus plugs or otherwise disrupts the water-conducting tissue (see eggplant and maple). The result of this appears as dark streaks inside the stem. It is often difficult, without a microscopic examination, to tell which wilt-producing fungus is involved.

certain plants such as potato, strawberry, and tomato differ in resistance. For *trees and shrubs*: Remove wilted branches. Sterilize tools between cuts by dipping or swabbing in 70 per cent denatured alcohol, then paint wound surfaces with a tree wound dressing (page 25).

C. Bacterial Wilt, Brown Rot, or Blight

Symptoms variable. See under plant involved. Some plants show dark green, water-soaked areas in leaves which expand rapidly. Leaves then turn brown and dry. Sometimes a shiny "crust" or "scale" is evident on affected plant parts. Plants may be stunted, wilt suddenly or gradually, starting with some of the younger leaves, or there may be a slight yellowing of the older leaves. Stems often shrivel and dry out. A yellowish slime or water-soaked browning may be evident when the base of the stem is cut through and squeezed. Bacterial soft rot often follows in wet weather. See (29) Bacterial Rots. The wilt-producing bacteria enter through insect, nematode, and other mechanical wounds.

Plants Attacked: Balsam, bean, beet, canna, cantaloup, carnation, carrot, cassava, castorbean, Chinese lanternplant, chrysanthemum, corn, cosmos, croton, cucumber, dahlia, delphinium, dieffenbachia, eggplant, forsythia, geranium,

gherkin, gourds, hibiscus, hollyhock, hydrangea, lettuce, lilac, marigold, muskmelon, nasturtium, nicotiana, okra, pea, peanut, pepper, petunia, potato, pumpkin, rhubarb, squash, sunflower, sweet-potato, tomato, verbena, wallflower, watermelon, and zinnia.

Control: Collect and burn infected plants. Control insects which may spread the disease using a mixture of methoxychlor or DDT and malathion. Resistant varieties are available for a few plants including cucumber, corn, carnation, and potato. Plant disease-free seed or treat before planting. See plant in question and Table 13 in the Appendix. Long crop rotation (6 years or more). Plant in well-drained, fertile soil, which is clean or sterilized. Indoors, raise temperature until disease is under control. Take cutting from healthy plants.

(16) **Mosaic, Mottle, Crinkle, Streak, Calico, Virus Leaf Curl, Infectious Variegation, Flower Breaking** This virus disease or complex shows variable symptoms. Most commonly the leaves have a mild to severe yellowing or a pattern of light and dark green areas forming a mosaic or mottle. Sometimes yellowish or white, ring or line patterns or both may be seen. Leaves are commonly curled, distorted, puckered, crinkled, leathery, or even cupped sharply

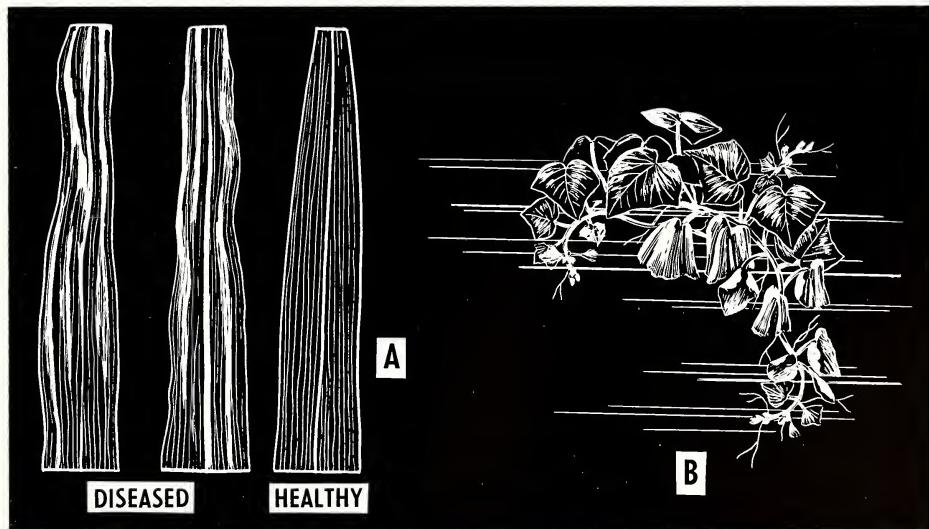
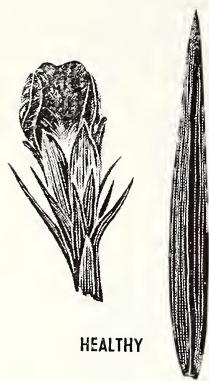
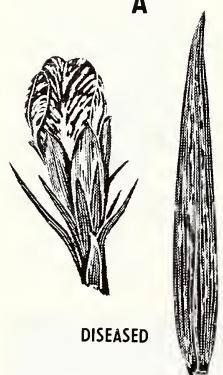


Fig. 31. Bacterial wilt. A. Corn, B. Cucumber. A sticky ooze is often evident when bacterial wilt-infected stems are cut and squeezed.



HEALTHY

A



DISEASED

C

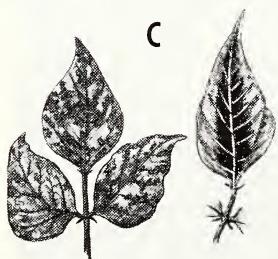
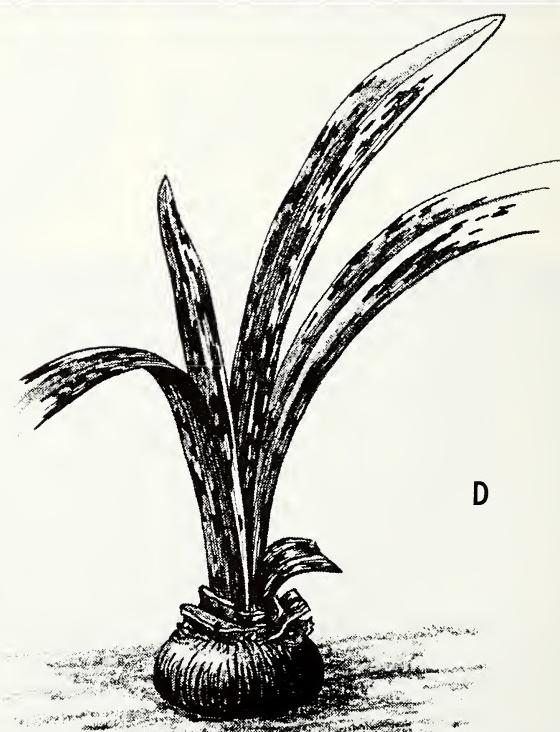


Fig. 32. Mosaic. A. Carnation, B. Tulip flower-breaking, C. Bean, D. Amaryllis.



B



D

downward or upward. Leaf veins may be lighter than normal (cleared) or be banded with dark green or yellow areas.

Flowers may be blotched or streaked with white or yellow, distorted, or fail to open normally.

Plants may be stunted; fruit deformed, stunted, fewer in number, and usually lack flavor. Infected plants often show no external symptoms, especially at high temperatures (85° F. or above).

Mosaiclike diseases are commonly spread by many species of aphids, some by contact — all by propagation (grafting, budding, slips) from infected plants.

Mosaics are often confused with plant nutrient deficiencies.

Plants Attacked: Abutilon, aconitum, African-lily, African-violet, almond, amaranth, amaryllis, Amazon-lily, anemone, apple, apple-of-Peru, apricot, aster, babiana, barberry, basil, bean, beet, begonia, bellflower, blackberry, blackberry-lily, bluegrass, bougainvillea, boysenberry, broccoli, Brussels sprouts, buttercup, butterflyweed, cabbage, calceolaria, calendula, candytuft, canna, cantaloup, cape-cowslip, cape-marigold, caraway, carnation, carrot, cassaba, catnip, cauliflower, celeriac, celery, chayote, cherry, chervil, chicory, China-aster, Chinese cabbage, Chinese hibiscus, Chinese lanternplant, chrysanthemum, cineraria, citron, clematis, coleus, columbine, coriander, corn, cornflower aster, cosmos, cranesbill, crimson daisy, crinum, crocus, cucumber, currant, dahlia, damesrocket, daphne, datura, delphinium, dewberry, dill, eggplant, elm, emilia, endive, erysimum, euonymus, evening-primrose, false-garlic, fennel, fig, fleabane, flowering cherry, flowering raspberry, flowering tobacco, foxglove, freesia, fritillaria, gaillardia, garden cress, garlic, geranium, gherkin, gladiolus, goldenchain, goldenglow, gooseberry, gourds, grape, groundcherry, ground-ivy, h a c k b e r r y , heliosperm, heliotrope, hibiscus, hollyhock, honesty, honeydew melon, honeysuckle, horseradish, houndstongue, hyacinth, hyacinth-bean, iris, ixia, Jerusalem-cherry, kale, kohlrabi, larkspur, lavatera, leek, lentil, lettuce, lilac, lily, lithospermum, lobelia, lupine, mallow, mangel, mangold, m a r i g o l d , matrimony-vine, mertensia, mock-cucumber, monarda, monkshood, morning-glory, muskmelon, mustard, narcissus, nasturtium, nectarine, New Zealand

spinach, nicotiana, nightshade, onion, orchids, oxeye daisy, pansy, parsley, parsnip, pea, peach, peanut, pear, penstemon, peony, pepper, peppergrass, periwinkle, petunia, phacelia, phlox, pinks, pitosporum, plum, potato, primrose, pro-boscisflower, pumpkin, purple-coneflower, radish, rape, raspberry, rhubarb, rose, rudbeckia, rutabaga, salvia, sassafras, seakale, shallot, sida, sidalcea, skyrocket, snapdragon, soapberry, spiderlily, spinach, squash, squill, star-of-Bethlehem, stock, stokesia, strawberry, streptantha, summer-hyacinth, sunflower, sweet alyssum, sweetpea, sweetpotato, sweet-william, Swiss chard, teasel, thimbleberry, tigerflower, tobacco, tomato, tritonia, tulip, turnip, verbena, vinca, violet, wallflower, wand-flower, watercress, watermelon, watsonia, wheatgrass, wisteria, and zinnia.

Control: Use resistant varieties where adapted. Control insects, especially aphids, using malathion, nicotine sulfate, or lindane. Destroy infected garden plants when first found as they will not recover. Keep down weeds in and around the garden area which may harbor viruses. Use virus-free stock — certified or indexed if possible. Destroy crop debris after harvest by burning or plowing under cleanly. Do not propagate from infected plants.

(17) Spotted Wilt, Ringspot Symptoms vary with the particular virus-plant combination. Leaves often show yellowish or dead concentric rings, oakleaf, zigzag, or watermark patterns, sometimes with green or yellow centers. Young leaves are usually puckered and malformed. Plants are often stunted; yield is sharply reduced. Yet some plants apparently recover. Foliage may be bronzed with dead spots developing. Stems and petioles may show lengthwise dark streaks or rings. Stem tips often appear blighted, may collapse. The viruses are spread by thrips and possibly other insects.

Plants Attacked: Almond, amaryllis, anemone, apricot, aster, bean, beet, begonia, blueberry, broccoli, Brussels sprouts, browallia, buttercup, butterfly-flower, cabbage, calceolaria, calendula, California-poppy, calla, candytuft, cantaloup, Canterbury-bells, carnation, cassaba, cauliflower, celeriac, celery, cherry, chicory, China-aster, Chinese lanternplant, chrysanthemum, cineraria, columbine, corn,

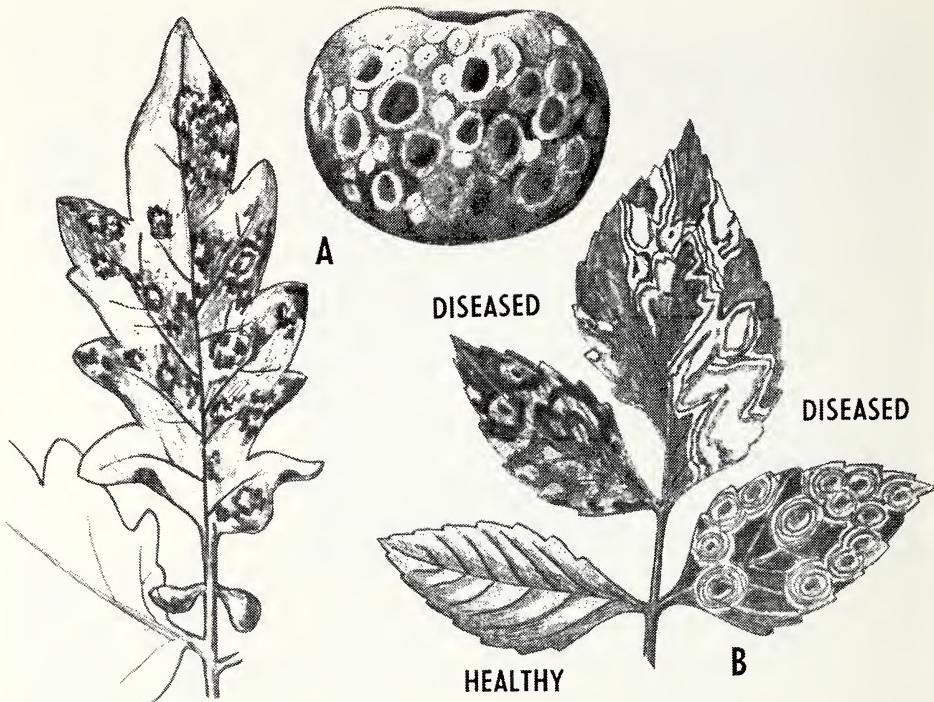


Fig. 33. Spotted wilt. A. Tomato, B. Dahlia. Note the wide range of symptoms produced. On dahlia the viruses are sometimes called ringspot, yellow ringspot, and oakleaf disease.

cosmos, cucumber, dahlia, datura, delphinium, eggplant, emilia, endive, erysimum, fleabane, flowering tobacco, fox-glove, fuchsia, gaillardia, garden cress, geranium, gilia, gladiolus, gloxinia, godetia, gourds, groundcherry, hydrangea, iris, Jerusalem-cherry, kale, kohlrabi, lettuce, lilac, lily, lobelia, lupine, lychnis, mallow, mignonette, muskmelon, mustard, narcissus, nasturtium, New Zealand spinach, nicotiana, okra, orchids, pansy, parsnip, pea, peach, penstemon, peony, peperomia, pepper, petunia, plum, poppy, potato, primrose, privet, pumpkin, radish, rape, rhubarb, salvia, satin-flower, scabiosa, sea-lavender, spinach, squash, stock, strawflower, sunflower, sweet alyssum, sweetpea, sweet-william, Swiss chard, tidy-tips, tobacco, tomato, turnip, verbena, vinca, violet, wallflower, watermelon, yellow ironweed, and zinnia.

Control: Destroy infected plants when first seen. Keep down weeds in and around the garden area, e.g., bindweed,

nettle, mallow, chickweed, galinsoga, etc. Control insects, especially thrips. Use DDT or methoxychlor and malathion. Plant disease-free stock. Destroy crop debris after harvest.

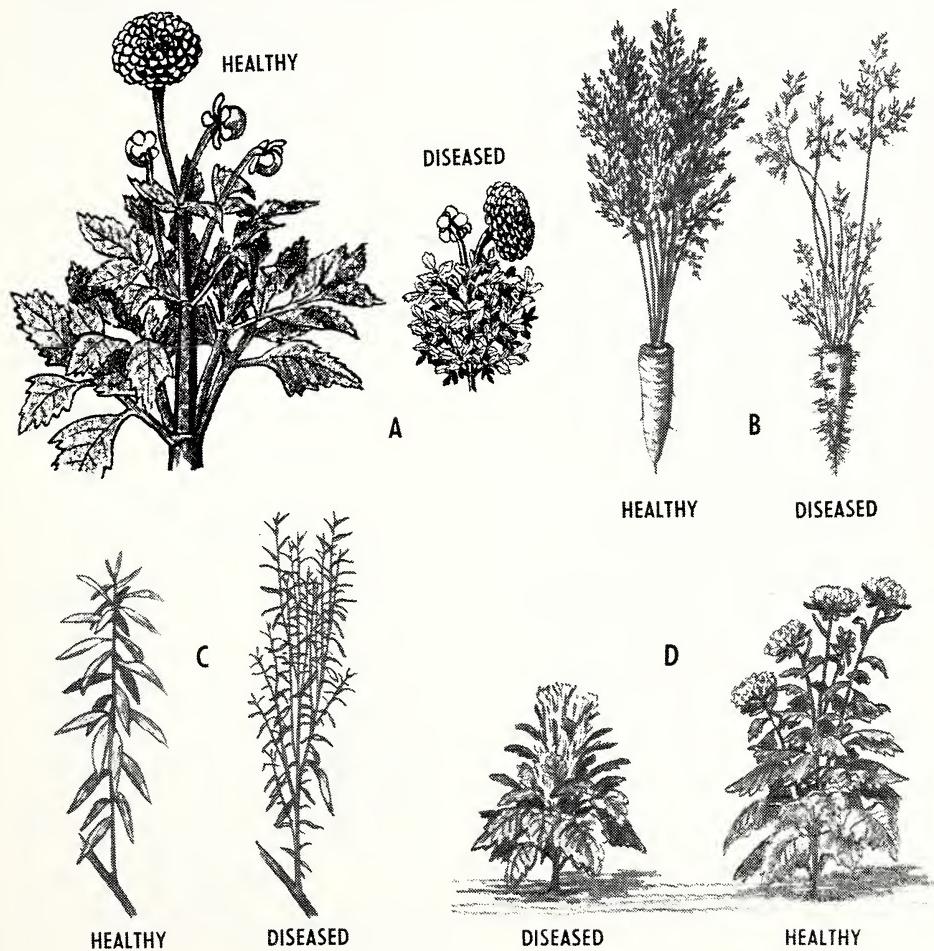
(18) **Yellows, Aster Yellows, Rosette, Dwarf, Stunt** Symptoms variable depending on the virus-plant combination and weather factors. Entire plants, or certain parts, are often more or less uniformly yellow (sometimes red or purple), stunted, or dwarfed. May wilt and die prematurely. Leaves and shoots may be slender and stunted forming tight, upright "rosettes." Fruit may ripen prematurely. Usually lacks flavor or may be "warty." Flowers may be greenish, dwarfed, aborted, or even absent. The viruses are spread primarily by leafhoppers (or aphids for a few viruses) and by propagating infected stock which may appear normal.

Plants Attacked: Allium, almond, alyssum, amaranthus, anagallis, anchusa, anemone,

anise, apricot, artichoke, avens, babys-breath, bachelors-button, basketflower, bayberry, bean, beet, begonia, bellflower, blackberry, black-salsify, blueberry, blue laceflower, broccoli, browallia, bur-marigold, buttercup, butterfly-flower, cabbage, calendula, California-poppy, camomile, canna, Canterbury-bells, cape-marigold, caraway, cardoon, carnation, carrot, cauliflower, celeriac, celery, centaurea, cherry, chicory, China-aster, Chinese cabbage, chrysanthemum, cineraria, clarkia, clock-vine, cockscomb, cornflower, corn-marigold, cosmos, crimson daisy, cucumber, dahlia, daisies, delphinium, dewberry,

dianthus, dill, eggplant, endive, English daisy, escarole, eupatorium, fennel, firewheel, flax, fleabane, forget-me-not, gailardia, garlic, geranium, gilia, gladiolus, globe-amaranth, globe artichoke, gloxinia, godetia, goldenglow, grape, groundsel, gypsophila, heronsbill, leek, lettuce, lily, lobelia, loganberry, love-lies-bleeding, mallow, mangel, mangold, marguerite, marigold, matricaria, mignonette, monkey-flower, mullein-pink, muskmelon, mustard, nasturtium, nectarine, New Zealand spinach, onion, oxeye daisy, painted-tongue, pansy, parsley, parsnip, pea, peach, peanut, petunia, phlox, pimpernel,

Fig. 34. Yellows or stunt. A. Dahlia stunt, dwarf, or mosaic, B. Aster yellows on carrot, C. Peach yellows, D. Aster yellows on aster.



piqueria, plum, potato, primrose, prune, pumpkin, pyrethrum, radish, rape, raspberry, rudbeckia, rutabaga, salsify, salvia, sassafras, satin-flower, scabiosa, sea-lavender, shallot, sneezeweed, speedwell, spinach, squash, statice, strawberry, strawflower, summer-cypress, sunflower, Swan River daisy, sweet alyssum, sweet-william, Swiss chard, tickseed, toadflax, tomato, vegetable-marrow, vinca, wallflower, and zinnia.

Control: Same as for Mosaic and Spotted Wilt. Control insects, especially leafhoppers (and a few aphids) which transmit the viruses. Use DDT or methoxychlor and malathion at least weekly, when insects are present or expected. Asters, certain other flowers, and lettuce are often grown under fine cheesecloth (22 threads per inch) or wire screening (18 threads per inch) to keep out insects.

(19) Curly-Top, Western Yellow Blight

Common and destructive in the western United States and other areas where light intensity and summer temperatures are high and the relative humidity is low. Symptoms vary with virus-plant combination. Plants usually stunted or dwarfed with leaves mottled, bunched, curled downward, rolled, thickened, and yellowed. Flowers and buds may drop early. **Plants Attacked:** Alyssum, amaranthus, bean, beet, broccoli, buttercup, cabbage, campanula, cantaloupe, carnation, carrot,

cassava, cauliflower, celeriac, celery, chervil, China-aster, Chinese cabbage, Chinese lanternplant, chrysanthemum, citron, cockscomb, collards, columbine, coriander, cornsalad, cosmos, cress, cucumber, delphinium, dill, eggplant, fennel, flowering flax, flowering tobacco, four-o'clock, foxglove, geranium, gherkin, globe-amaranth, godetia, groundcherry, heliotrope, heronsbill, honeydew melon, horseradish, kochia, larkspur, lettuce, lobelia, mallow, mangel, marguerite, mignonette, mock-cucumber, morning-glory, muskmelon, mustard, nasturtium, New Zealand spinach, nicotiana, okra, oxalis, pansy, parsley, parsnip, pepper, peppergrass, petunia, phacelia, pinks, poppy, potato, pumpkin, pyrethrum, radish, rhubarb, rose-moss, rutabaga, salad chervil, salsify, scabiosa, Shasta daisy, spiderflower, spinach, squash, stock, strawflower, sweetpotato, sweet-william, Swiss chard, tickseed, tomato, turnip, vegetable-marrow, veronica, vinca, violet, watermelon, and zinnia.

Control: Same as for Yellows. Plant as early as possible or at the time recommended for your area.

(20) Leaf, Bud, Stem, and Leaf Gall Nematodes

Symptoms variable with plant host. The nematodes live over winter in the soil or in infested leaves and stems. During the growing season the nematodes may swim up the stem in a film of water. Infestation only occurs when plants have

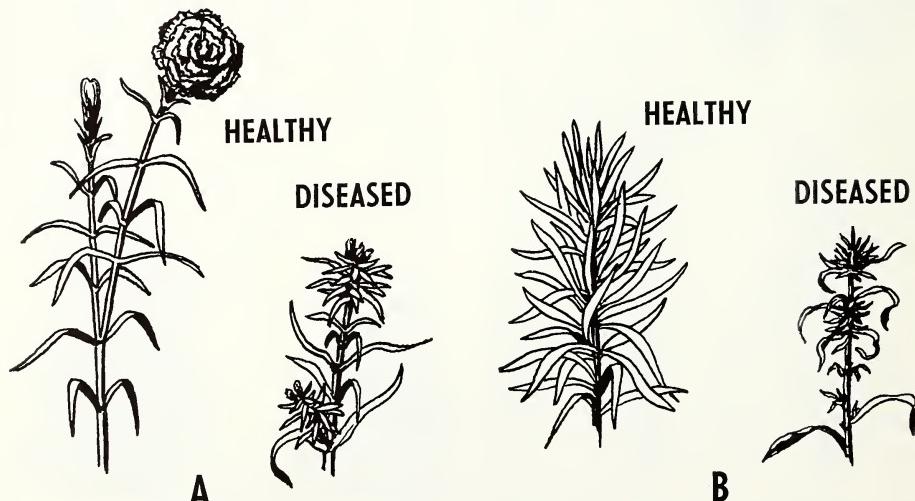


Fig. 35. Curly-top. A. Carnation, B. Strawflower.

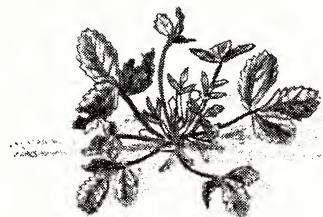


A



B

HEALTHY



DISEASED

Fig. 36. Leaf, stem, and leaf gall nematodes. A. Chrysanthemum foliar or leaf nematode, B. Strawberry dwarf or crimp.

been wet as a result of rain, sprinkling, heavy dew, and fog.

1. *Begonia, chrysanthemum, ferns, lantana, orchids* — Dark brown to black, angular, or wedge-shaped areas on the leaves. Often delimited by the leaf veins. Leaves may wither and die starting at the base of the plant.
2. *Strawberry* — Leaves often stunted, narrow, twisted, crinkled, and cupped (*spring and summer crimp or dwarf*).
3. *Bellflower, sweet-william* — Leaves very narrow, crinkled, wavy, often brittle. Stems may be swollen near the tops, or curved sideways. Infested plants are stunted, fail to bloom, or may die prematurely.
4. *Lily* — Leaves are bronzed, gnarled, blotched, and curled tightly downward (*bunchy top*), later die back.

See (38) Bulb Nematode.

Plants Attacked: African-violet, anemone, aster, balsamroot, beet, begonia, bell-

flower, bentgrass, bouvardia, butter-and-eggs, buttercup, butterfly-flower, calceolaria, carrot, celery, chrysanthemum, clematis, coleus, coralbells, crassula, cyclamen, dahlia, daisy, delphinium, evening-primrose, ferns, four-o'clock, foxglove, garden cress, garlic, geranium, glory-of-the-snow, gloxinia, gooseberry, grape-hyacinth, groundcherry, ground-pink, groundsel, heuchera, hyacinth, hydrangea, lantana, leopardsbane, lily, loosestrife, lupine, marigold, monkeyflower, moonflower, narcissus, onion, orchids, oxalis, oxeye daisy, pansy, parsley, parsnip, peony, pepper-grass, phlox, pinks, piqueria, poppy, primrose, potato, privet, radish, rape, rhubarb, salsify, salvia, scabiosa, schizanthus, snowdrop, strawberry, sunflower, sweetpotato, sweet-william, teasel, toadflax, tomato, tulip, verbena, violet, wyethia, and zinnia.
Control: Buy clean plants, certified and heat-treated if possible. Take *tip* cuttings from healthy plants. Collect and burn infested plants or plant parts as soon as

noticed. Burn tops at the end of the season. Avoid overhead watering. Keep water off the foliage. Apply a dry mulch. Practice a 2-year rotation. Where practical, apply malathion twice weekly until nematodes are controlled. Certain potted plants, such as African-violet, begonia, and ferns may be dipped in hot water to rid them of nematodes.

B. Stem Diseases

(21) Crown, Foot, Stem, Stalk, Collar, or Rhizome Rot; Stem Blight, Southern Blight, Damping-off Plants are generally first unthrifty with leaves smaller and lighter green than normal. Leaves may later turn yellow or wilt, wither, and curl during hot, dry periods. Base of stems may be water-soaked and discolored and rotten. Leaves then wilt, turn yellow, wither, and eventually die. Roots may decay. Seedlings usually wilt and collapse (damping-off). Stand may be poor. A cottony, or other

type of mold, may grow over affected plant parts. Variously shaped, tan to black bodies (sclerotia) may be formed in this mold growth. Plants often wilt and gradually or suddenly die when the basal rot shuts off the supply of water and nutrients to the aboveground plant parts. See (2) Bacterial Spot, (6) Downy Mildew, (29) Bacterial Soft Rot, (32) Fruit Spot, and (34) Root Rot.

Plants Attacked: Practically all plants.

Control: Plant in a light, well-drained, well-prepared soil or in a sterile rooting medium (pages 437-44), such as sand, soil, vermiculite, perlite, or sphagnum moss. Where possible, keep the soil on the dry side. Avoid overcrowding, overwatering, too deep planting, and overfertilizing (especially with nitrogen). Water seedlings at 5- to 7-day intervals with a solution containing 1 to $1\frac{1}{2}$ tablespoons of ferbam, ziram, captan, thiram, or zineb per gallon of water. Use about $\frac{1}{2}$ pint

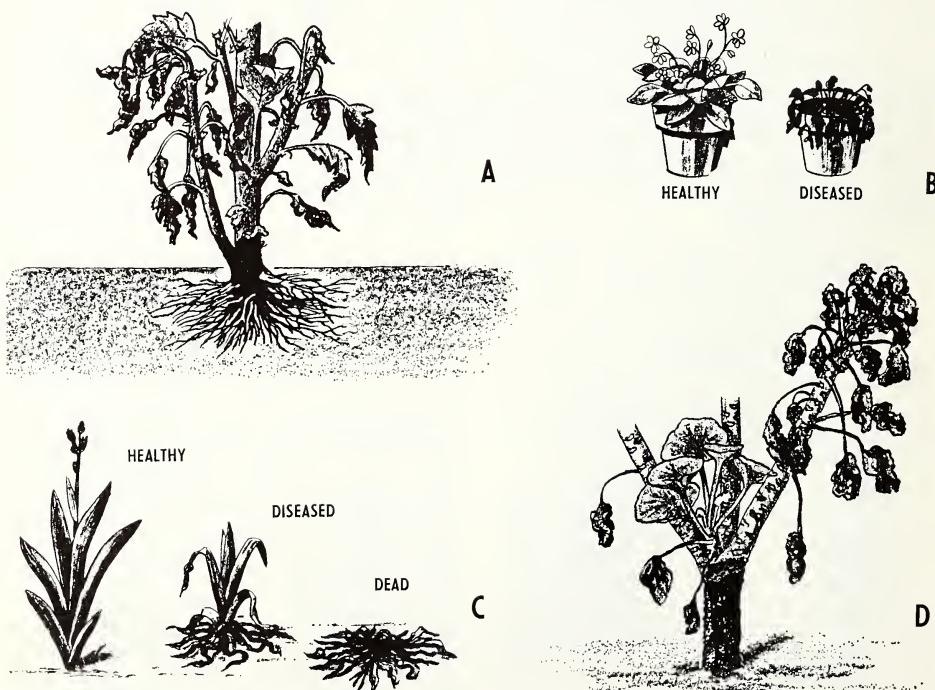


Fig. 37. Crown or stem rot. A. Chrysanthemum crown and root rot, B. African-violet, C. Crown, rhizome, or bulb rot of iris, D. Blackleg of geranium.

per square foot of bed surface. Where possible, sterilize the soil with heat or chemicals before planting. Buy disease-free, crack-free seed of vegetables and flowers. Treat seed with captan, thiram, or chloranil before planting, as given under the plant involved and Table 13 in the Appendix. Practice as long a crop rotation as practical. Carefully collect and burn infected plants and several inches of surrounding soil. Soak flower bed soil in the infected areas with a 1:1,000 solution of mercuric chloride (see page 85 for precautions), or apply Terraclor (PCNB) 75 per cent and thiram, captan, or phaltan ($\frac{1}{3}$ pound each per 100 square feet) to the soil surface before disease starts and mix into the top 5 to 6 inches of soil. Collect and burn all crop debris immediately after harvest, or plow under deeply and cleanly. Valuable plants may often be saved by taking tip cuttings or buds to start new plants.

(22) Stem, Twig, Branch, or Trunk Canker; Dieback; Stem, Cane, or Limb Blight Both fungi and bacteria are responsible for producing cankers on the stems, twigs, limbs,

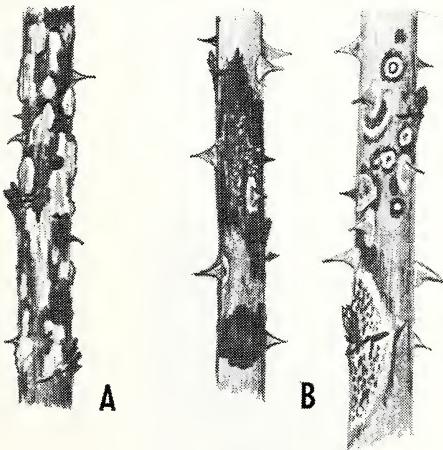


Fig. 38. Stem canker and anthracnose. A. Raspberry anthracnose, B. Various rose cankers.

and trunks. Cankers are usually definitely marked, shrunken, discolored areas (especially in the bark) which slow normal healing of wounds. Many cankers crack open, exposing the wood beneath. If the canker enlarges and girdles the stem, the parts above the diseased area

usually wilt, wither, and die back from the tip. See also under (14) Scab, (15) Wilts, (23) Wood Rot, and (24) Fire Blight.

Plants Attacked: Abutilon, acacia, alder, almond, amelanchier, American bladder-nut, amorphia, ampelopsis, apple, apricot, araucaria, arborvitae, arbutus, arrowwood, ash, asparagus, asparagus-fern, aspen, aster, aucuba, avocado, azalea, bald-cypress, barberry, bean, beech, beet, bignonia, birch, bittersweet, blackberry, black gum, black locust, bladder-senna, blueberry, Boston ivy, boxelder, boxwood, boysenberry, broccoli, broom, butterfly-bush, butternut, cabbage, cacti, caesalpinia, calendula, California-laurel, calliandra, calycanthus, camellia, camphor-tree, carissa, carnation, carrot, cassia, catalpa, cauliflower, ceanothus, cedar, cherry, cherry-laurel, chestnut, chicory, China-aster, chinaberry, chinquapin, chokeberry, chrysanthemum, clarkia, clematis, columbine, coralberry, cornel, cosmos, coton-easter, cottonwood, crabapple, cucumber, currant, cypress, daphne, delphinium, dewberry, dogwood, Douglas-fir, eggplant, elder, elm, English ivy, euonymus, exacum, fennel, fig, filbert, fir, flowering almond, flowering cherry, flowering currant, flowering quince, flowering raspberry, forsythia, foxglove, fuchsia, gardenia, geranium, gentian, goatsbeard, goldenchain, goldenlarch, goldenrain-tree, gooseberry, grape, grapefruit, hardhack, hardy orange, hawthorn, hazelnut, hemlock, Hercules-club, Hiba arborvitae, hibiscus, hickory, highbush cranberry, holly, hollyhock, holodiscus, honeydew melon, honeylocust, honeysuckle, hophornbeam, hornbeam, horsechestnut, India rubber tree, incense-cedar, inkberry, Japanese pagodatree, Japanese plum-yew, jasmine, jetbead, juniper, kalanchoë, kale, kerria, larch, lemon, lilac, lily, lime, linden, locust, London plane, loquat, lupine, magnolia, mallow, maple, meconopsis, "mimosa" tree, monkshood-vine, morning-glory, mountain-ash, mulberry, muskmelon, nectarine, oak, okra, oleander, onion, orange, osier, pachysandra, pagodatree, palms, papermulberry, parsnip, pawpaw, pea, peach, peanut, pear, pecan, pepper, persimmon, phlox, pine, pinks, planetree, plum, poinciana, poinsettia, poplar, potato, prairie-gentian, prickly-ash, privet, pumpkin, pyracantha, quince, radish, rape, rasp-

berry, redbay, redbud, redcedar, redwood, rhododendron, rhubarb, rose, rosemallow, Russian-olive, rutabaga, sassafras, senna, sequoia, serviceberry, silk-oak, silverberry, smoketree, snapdragon, snowberry, soapberry, sophora, sorreltree, spicebush, spinach, spirea, spruce, squash, sumac, stock, sweet alyssum, sweetgale, sweetgum, sweet-pea, sweetpotato, sweet-william, sycamore, thimbleberry, tomato, tree-of-Heaven, tuliptree, tupelo, turnip, umbrella-pine, viburnum, vinca, Virginia-creeper, walnut, watermelon, weigela, white-cedar, willow, wisteria, wolfberry, woodwaxen, yellow-cedar, yellowwood, yew, and zinnia.

Control: Carefully prune out and burn infected plant parts, cutting one to several inches behind the canker and including all discolored wood. On trees and shrubs, where practical, sterilize pruning shears between cuts by dipping or swabbing with 70 per cent denatured alcohol. Follow the spray schedules for fruits listed in Table 10 in the Appendix. Spraying with a multipurpose spray may be beneficial to certain flowers, shrubs, and vegetables. Treat seed of vegetables and flowers as in Table 13 of Appendix. Plant in sterilized soil and avoid overwatering. Treat bark

and wood injuries of trees and shrubs promptly by covering with a tree wound dressing (page 25). Keep plants growing vigorously through fertilization, pruning, and watering during droughts. Avoid wounding plants. Plant resistant varieties where possible.

(23) Wood, Butt, Wound, Heart, or Sapwood Rot Certain fungi cause spongy or hard rots in both living and dead woody plants. Damage usually occurs slowly, often over a period of many years. Infection occurs almost entirely through unprotected wounds such as pruning cuts, mowing bruises, breaks due to ice and windstorms, etc. Wood rots are often indicated by external, punky to woody, hoof- or shelf-shaped fungus structures (conks), or by clusters of small toadstools at the base of the trunk, or at wounds. Affected wood may be discolored or stained. See also (34) Root Rot.

Plants Attacked: Practically all woody plants.

Control: Promptly treat bark and wood injuries with a tree wound dressing (page 25) to prevent wood-rotting fungi from becoming established. If rot is evident, cut out cleanly all diseased wood and bark.

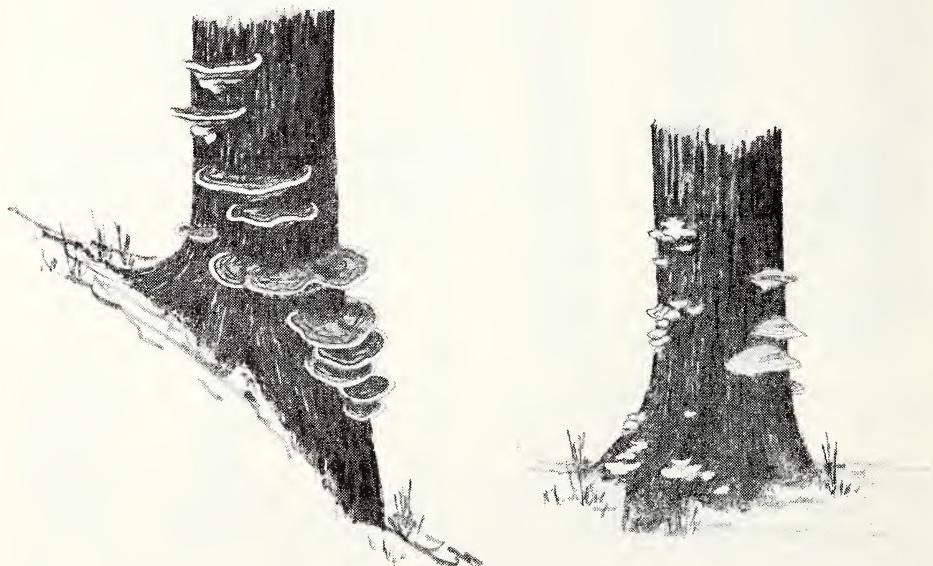


Fig. 39. Several types of fungus fruiting bodies (conks) which indicate wood rot is within.

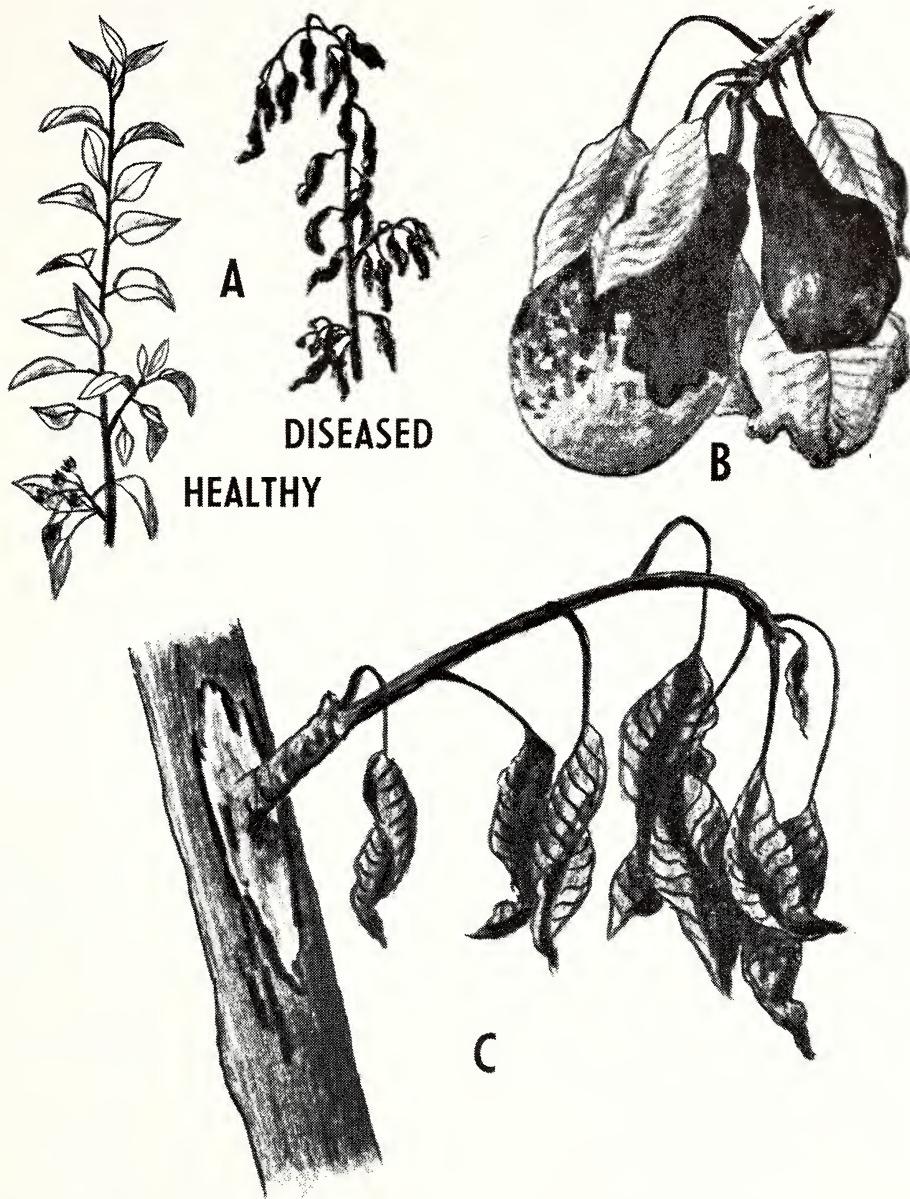


Fig. 40. Fire Blight. A and C. Apple, B. Pear. Note that in C infection has progressed down the shoot and is producing a canker in the branch.

Sterilize the cavity by painting with household bleach (diluted 1 to 5 with water) or a 1:1,000 solution of mercuric chloride (see page 85 for precautions). Then cover with wound dressing. Keep plants growing vigorously by fertilization, pruning, and watering.

(24) Fire Blight, Bacterial Shoot Blight, Bacterial Canker, Gummosis Blossoms, leaves, and fruit suddenly turn brown or black and shrivel as if scorched by fire, but cling to twigs. Twigs are shrunken and brown to black. The twig tips are often bent to form "shepherds' crooks." Rapidly growing shoots (e.g., watersprouts and suckers) are especially susceptible. The fire blight bacteria live-over in branch and trunk cankers. These cankers are slightly sunken, discolored areas with a sharp margin (or slight crack) separating healthy and diseased bark tissues. Fire blight is spread from overwintering cankers to blossoms, leaves, and young twigs by insects, splashing rain, wind, and pruning tools. See (2) Bacterial Leaf Spot and Blight. Blight is active from about the blossoming period until rapid shoot growth ceases.

Plants Attacked: Almond, amelanchier, apple, apricot, avens, blackberry, cherry, chokeberry, cinquefoil, cotoneaster, crabapple, flowering almond, flowering cherry, flowering quince, goatsbeard, hawthorn, holodiscus, jetbead, kerria, lilac, loquat, medlar, mountain-ash, ninebark, peach, pear, photinia, plum, pyracantha, quince, raspberry, rose, serviceberry, spirea, stranvaesia, and strawberry.

Control: Use resistant varieties of apple, crabapple, and pear or species of cotoneaster and pyracantha. See under Apple. *Avoid* heavy fertilization (especially using nitrogen), heavy pruning, and other practices which stimulate excessive growth. Grow trees in sod in well-drained soil. Cut out infected twigs and small limbs during the dormant season, pruning at least 4 inches back from the canker margin. Cut out cankers on large limbs or trunk and disinfect the wound before coating with a tree wound dressing to which Elgetol or Krenite has been added as a disinfectant (page 25). Disinfect pruning tools between cuts by dipping them in 70 per cent denatured alcohol or a 1:1,000 solution of mercuric chloride (page 85). For additional information read USDA Leaf-

let No. 187, *Blight of Pears, Apples, and Quinces*.

If practical, spray with streptomycin or zineb at 3- to 5-day intervals beginning at very early bloom and continuing through the blossoming period. These sprays are expensive and will not control the serious twig blight stage which follows. Follow the manufacturer's directions.

(25) Black Knot Rough, black swellings on twigs and branches. Knots are covered

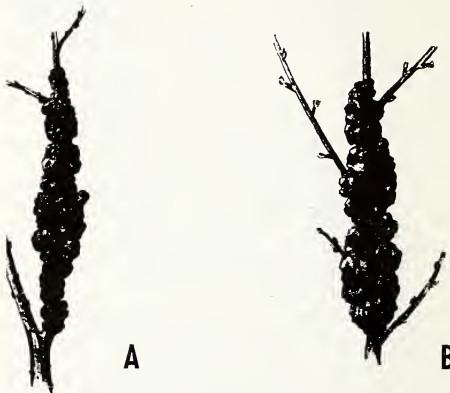


Fig. 41. Black Knot. A. Cherry, B. Plum.

with an olive-green, velvety surface in late spring. If left undisturbed, black knot may stunt and kill trees.

Plants Attacked: Apricot, cherry, Mayday-tree, peach, and plum.

Control: Cut out and burn infected twigs and branches during the dormant season. Make pruning cuts 3 to 4 inches back of the knot. Knots on large limbs should be removed by surgery (page 24). The cuts should go back into healthy wood. Cover pruning wounds with a tree wound dressing (page 25). Destroy nearby wild plums and cherries and any worthless fruit trees. Follow the spray program as outlined in Table 10 in the Appendix.

(26) Rust Powdery, yellow-orange galls or swellings on twigs, limbs, and trunk, or bean-shaped galls on junipers which become orange and gelatinous in spring rains. See (8) Rust.

(27) Smut Sooty, powdery masses on stems and branches. See (11) Smut.

(28) Leafy Gall, Fasciation, Witches'-broom Symptoms variable. Dwarfed, thick, aborted shoots with distorted leaves de-

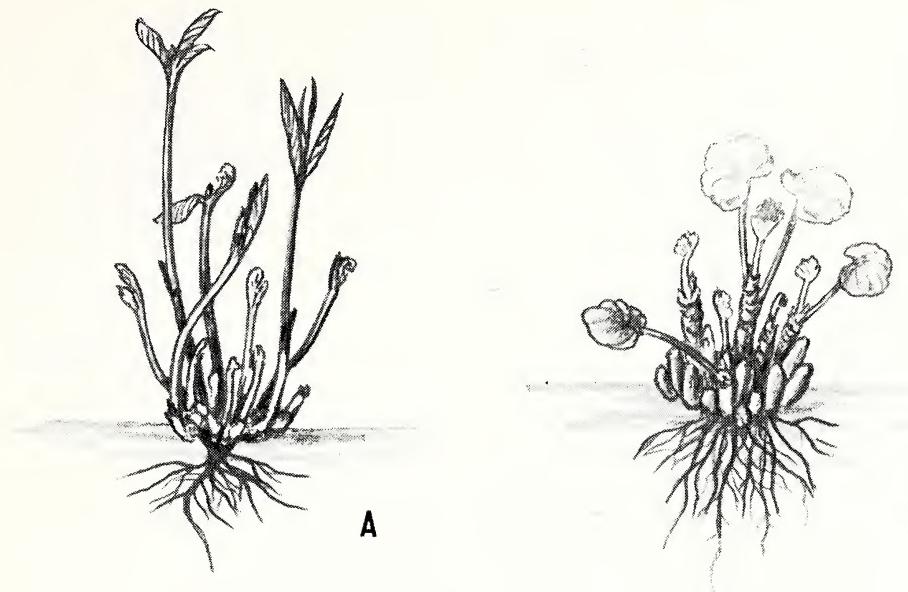


Fig. 42. Leafy gall or fasciation. A. Sweetpea, B. Geranium.

velop near the soil line. Main stem is stunted. Few flowers are produced. See (30) Crown Gall.

Plants Attacked: Babysbreath, butterfly-flower, carnation, chrysanthemum, dahlia, geranium, hollyhock, nasturtium, nicotiana, petunia, phlox, piqueria, pyrethrum, Shasta daisy, strawberry, and sweet-pea.

Control: Where practical, dig up and burn infected plants. Plant disease-free seed or dip 1 minute in alcohol, then soak 20 minutes in a 1:1,000 solution of mercuric chloride (see page 85 for pre-

cautions). Rinse and wash well in running water before drying and dusting the seed with thiram or captan. Sterilize soil in flower beds or use fresh soil (pages 437-44). Maintain good cultural practices. Plant disease-free stock. Practice a 3-year rotation.

(29) Bacterial Soft Rot, Bacterial Stem Rot, Collar Rot Rapid, mushy, slimy, or "cheesy" rot, usually with a putrid odor. Roots, stems, fleshy tubers, bulbs, buds, leaves, and fruit become soft, watery, and pulpy. Foliage wilts, shrivels, and may collapse when lower stem or underground

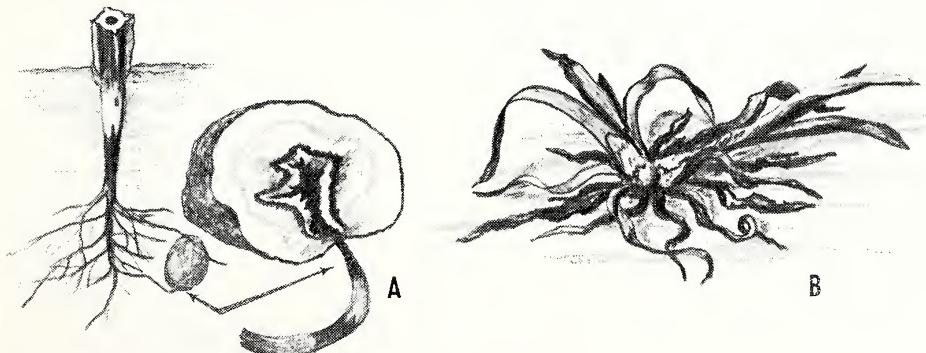


Fig. 43. Bacterial soft rot. A. Soft rot and blackleg of potato, B. Iris.

parts rot. Infections occur through wounds. Rot is most destructive in warm, moist weather. See also under (21) Crown Rot, (32) Fruit Spot, and (36) Bulb Rot.

Plants Attacked: Apple, artichoke, asparagus, bean, beet, broccoli, Brussels sprouts, cabbage, cacti, caladium, calla, canna, cantaloup, carrot, cassaba, cauliflower, celeriac, celery, chicory, Chinese cabbage, chrysanthemum, citron, collards, corn, cucumber, cyclamen, cypress, dahlia, dashen, delphinium, dieffenbachia, eggplant, elephants-ear, endive, escarole, European cranberry-bush, fennel, ferns, finocchio, fittonia, garlic, geranium, gladiolus, gourds, horseradish, hyacinth, iris, Jerusalem-cherry, kale, kohlrabi, leek, lettuce, lily, mangel, muskmelon, mustard, nightshade, okra, onion, orchids, pansy, parsley, parsnip, pea, pear, pepper, poinsettia, potato, pumpkin, radish, rape, redwood, rhubarb, rutabaga, salsify, sansevieria, shallot, spinach, squash, strawberry, sweet-potato, tomato, tuberose, tulip, turnip, violet, and watermelon.

Control: Avoid planting in poorly drained, unfertile soil. Treat soil before planting using aldrin, dieldrin, chlordane, etc., to control soil insects. Carefully dig up and burn infected plants. When rot starts in flower beds, disinfect soil by drenching with a 1:1,000 solution of mercuric chloride (see page 85 for precautions). Repeat treatment 10 days later. Spray to control foliage-feeding insects using DDT or methoxychlor plus malathion. Control foliage blights, fruit rots, and other diseases. Practice a long crop rotation. Avoid wounding plants when cultivating, digging, etc. Store only dry, sound, vegetables and fruits in a dry, well-ventilated room at the recommended temperature and humidity. The storage area should first be swept clean. Then spray all surfaces from ceiling to floor with a formaldehyde solution (1 pint of commercial 37 per cent formalin in 10 gallons of water) or scrub down with a copper sulfate solution (1 pound in 5 gallons of water) before storing fruits, vegetables, roots, etc. Leafy vegetables should be precooled to 45° F. or below and then placed in cold storage as soon after harvest as possible.

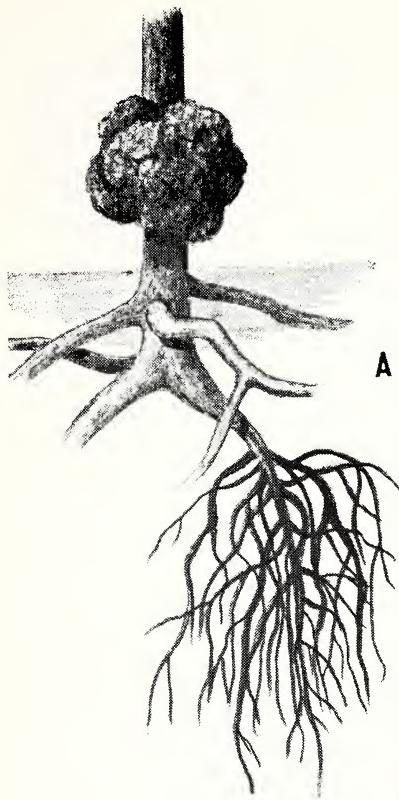
For *calla* and *iris*: Cut out rotted portion in bulb, corm, or rhizome. Then dry thoroughly for a day or two. Before plant-

ing soak in a 1:1,000 solution of mercuric chloride.

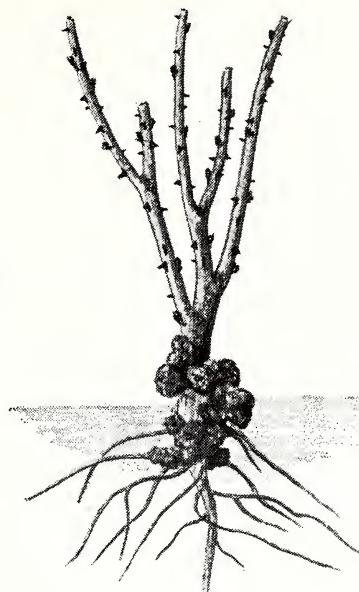
(30) Crown Gall, Cane Gall, Hairy Root, Bacterial Root Gall Rough-surfaced, hard or soft and spongy, swollen tumors or galls, up to several inches in diameter. May be flesh-colored, greenish or dark. Galls are usually found at or near the soil line, at the graft or bud union, or on the roots and stems. Small, fibrous roots are sometimes profuse, may resemble "witches'-brooms." These occur at the base of the trunk, crown, or on the larger roots. As the disease progresses, plants often become stunted and sickly. May eventually die. The crown gall bacteria enter through wounds. Easily confused with callus overgrowths formed at wounds or graft unions — which are perfectly normal. Corn, onions, asparagus, grasses, and cereals are immune.

Plants Attacked: Achillea, almond, apple, apricot, araucaria, arbutus, artemisia, ash, asparagus-fern, aster, azalea, babysbreath, balsam, bean, beet, begonia, bittersweet, blackberry, blueberry, boysenberry, cabbage, cacti, caesalpinia, calendula, calyculanthus, camellia, cape-jasmine, carnation, carrot, castorbean, catalpa, chamaecyparis, cherry, chrysanthemum, cinquefoil, clematis, clockvine, cotoneaster, cottonwood, crabapple, cucumber, cypress, dahlia, daisy, delphinium, dewberry, dogwood, Douglas-fir, euonymus, fig, filbert, flowering quince, forsythia, foxglove, geranium, grape, grapefruit, hazelnut, hibiscus, hickory, hollyhock, honeylocust, honeysuckle, horseradish, incense-cedar, India rubber tree, jasmine, Jerusalem-artichoke, Jerusalem-cherry, juniper, kalanchoë, lemon, lettuce, lilac, lippia, loquat, lupine, mallow, mangel, mangold, maple, marguerite, mountain-ash, mulberry, muskmelon, nectarine, New Jersey-tea, nicotiana, oak, orange, parsnip, peach, pear, pea-tree, pecan, peony, persimmon, phlox, plum, poinciana, poinsettia, poplar, potato, privet, quince, radish, raspberry, redcedar, rhubarb, rose, rosemallow, Russian-olive, rutabaga, Shasta daisy, snapdragon, snowberry, spirea, Sprenger asparagus, strawberry-tree, sumac, sunflower, sweetpea, tomato, turnip, viburnum, walnut, weigela, white-cedar, willow, witch-hazel, wisteria, wormwood, yew, and yucca.

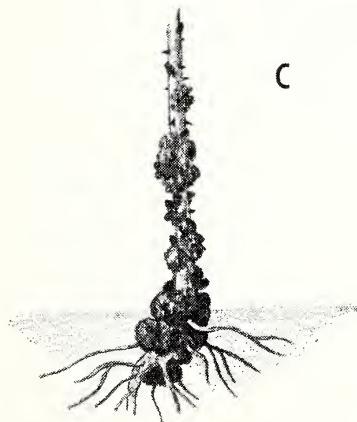
Control: Carefully dig up and burn infected plants, especially woody ones. Remove as many of the infected roots as



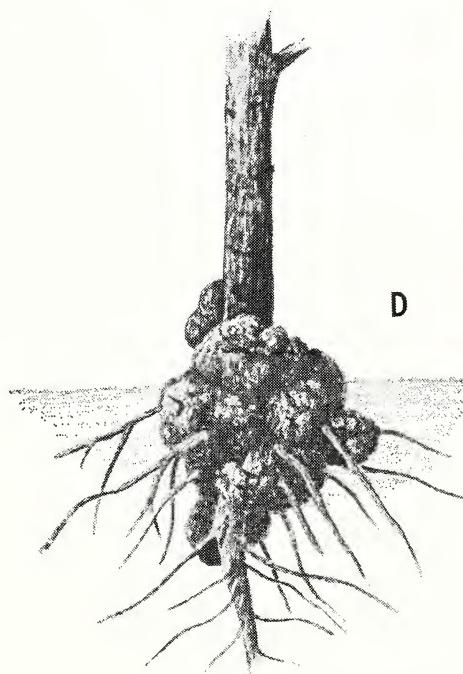
A



B



C



D

Fig. 44. Crown gall. A. Apple, B. Rose, C. Crown and cane gall of raspberry, D. Peach.

possible. Practice at least a 3-year rotation or avoid replanting in the same location for that period or longer. Reject plants showing suspicious bumps near the crown, former soil line, or graft union. Budding is preferable to grafting. Where suspicious, dip grafting knives in 70 per cent denatured alcohol between cuts. Avoid wounding plants when cultivating, etc. Disinfestation of infested soil using steam or chemicals (e.g., Vapam, V.P.M. Soil Fumigant, D-D, EDB, chloropicrin, etc.) is seldom complete unless the soil is in confined containers (pages 437-44). Maintain the soil as acid as practical (below pH 5.5) for vegetables. Control insects by sprays of malathion and methoxychlor or DDT. Some nurserymen dip woody planting stock immediately after digging in a Terramycin solution (about 400 parts per million) for 15 minutes, followed by air drying. Others dip planting stock in a 1:1,000 solution of mercuric chloride for 1 to 10 minutes. If galls are severe on larger trees, call in a reputable arborist. He will probably excavate, chisel off the outer gall tissue, and paint the gall and its margins with a mixture of Elgetol (1 part) and methanol (4 or 5 parts). The damaged areas should then be painted with a tree wound dressing (page 25).

C. Flower and Fruit Diseases

(31) Flower or Blossom Blight, Ray or Inflorescence Blight Flowers spotted, often wither or rot, causing fruit not to set, or young fruit may rot and drop early. Flowers and young fruit may be covered with dense mold growth during and following moist weather. See also under (5) Botrytis Blight, (6) Downy Mildew, (7) Powdery Mildew, (9) White Rust, (11) Smut, (16) Mosaic and Flower Breaking, (18) Yellows, (19) Curly-top, (24) Fire Blight, and (38) Bulb Nematode.

Plants Attacked: African-violet, almond, amaranth, amelanchier, anemone, apple, apricot, aucuba, avocado, azalea, blackberry, blueberry, calla, camellia, castor-bean, cherry, Chinese hibiscus, cherry-laurel, chokeberry, Christmas-rose, chrysanthemum, cornflower aster, crabapple, cucumber, cyclamen, dahlia, delphinium, dewberry, dogwood, flowering almond, flowering cherry, flowering quince, forsythia, foxglove, geranium, gladiolus, haw-

thorn, hibiscus, hyacinth, hydrangea, iris, Japanese quince, jasmine, lilac, lily, loquat, magnolia, Maltese cross, maple, marigold, mistflower, mockorange, morning-glory, mountain-ash, mountain-laurel, narcissus, nectarine, okra, orchids, palms, pea, peach, pear, peony, pepper, petunia, plum, pumpkin, quince, raspberry, rhododendron, rose, rose-of-Sharon, snapdragon, snowberry, squash, strawberry, stock, stokesia, sumac, sweetpea, thimbleberry, tomato, tuberose, tulip, verbena, viburnum, yucca, and zinnia.

Control: Treat flower and vegetable seed before planting as given in Table 13 in the Appendix. Follow spray or dust schedules for vegetables and fruit. Spray others with captan, thiram, zineb, maneb, or a copper-containing fungicide. Apply a light, misty spray of zineb at 3- to 5-day intervals during bloom. Rotate garden plantings. If practical, carefully remove affected and fading flowers and young fruit when first noticed. Place in a paper sack and burn. Space plants. Avoid overhead sprinkling. Plant in well-drained soil.

(32) Fruit Spot, Speck, Rot, or Blotch; Seed, Berry, or Tuber Rot; Storage Rot Fruit, tuber, berry, etc., shows one or more spots. Spots often enlarge and run together. Whole fruit may later rot and shrivel. Frequently starts at the blossom or stem-end or on the underside of fruit when resting on damp soil. Bacterial Soft Rot may follow causing a mushy or watery, foul-smelling decay. See also under (6) Downy Mildew, (10) Leaf Curl, (11) Smut, (12) Sooty Mold, (14) Scab, (16) Mosaic, (21) Crown Rot, (29) Bacterial Soft Rot, (31) Flower Blight, and (36) Bulb Rot.

Plants Attacked: Almond, amelanchier, apple, apricot, artichoke, avocado, barberry, bean, beet, blackberry, blueberry, boysenberry, butternut, cabbage, cantaloup, carrot, cassaba, cauliflower, celery, chayote, cherry, chestnut, China-aster, chokeberry, citron, coralberry, crabapple, cucumber, currant, dahlia, dasheen, dewberry, eggplant, endive, feijoa, fig, flowering almond, flowering quince, fragrant glad, gaultheria, gladiolus, gooseberry, gourds, grape, grapefruit, guava, hardy orange, hawthorn, hazelnut, hickory, honeydew melon, huckleberry, kumquat,

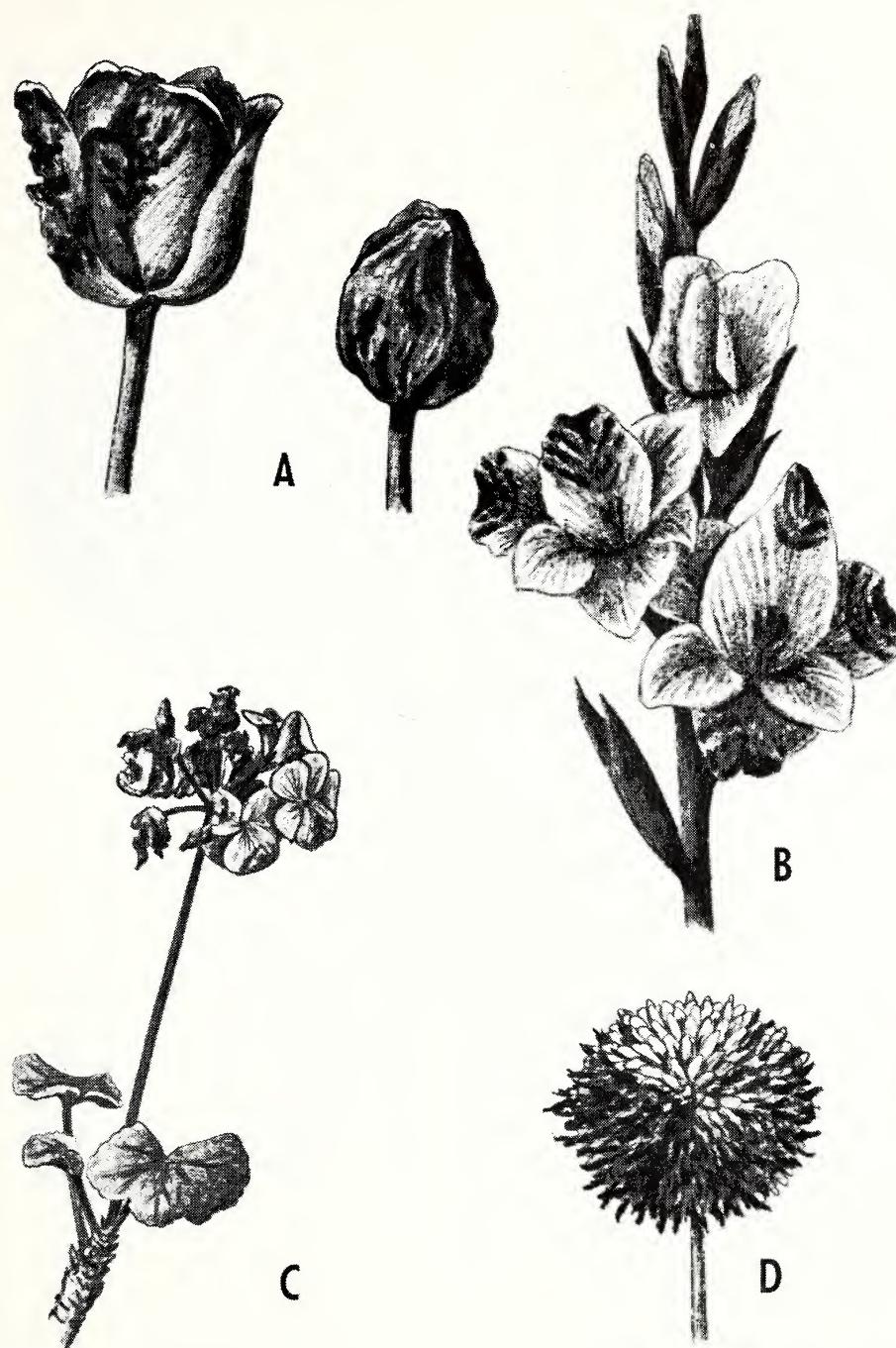


Fig. 45. Flower blight. A. Tulip fire, B. Gladiolus, C. Botrytis blight on geranium, D. Head blight of chrysanthemum.

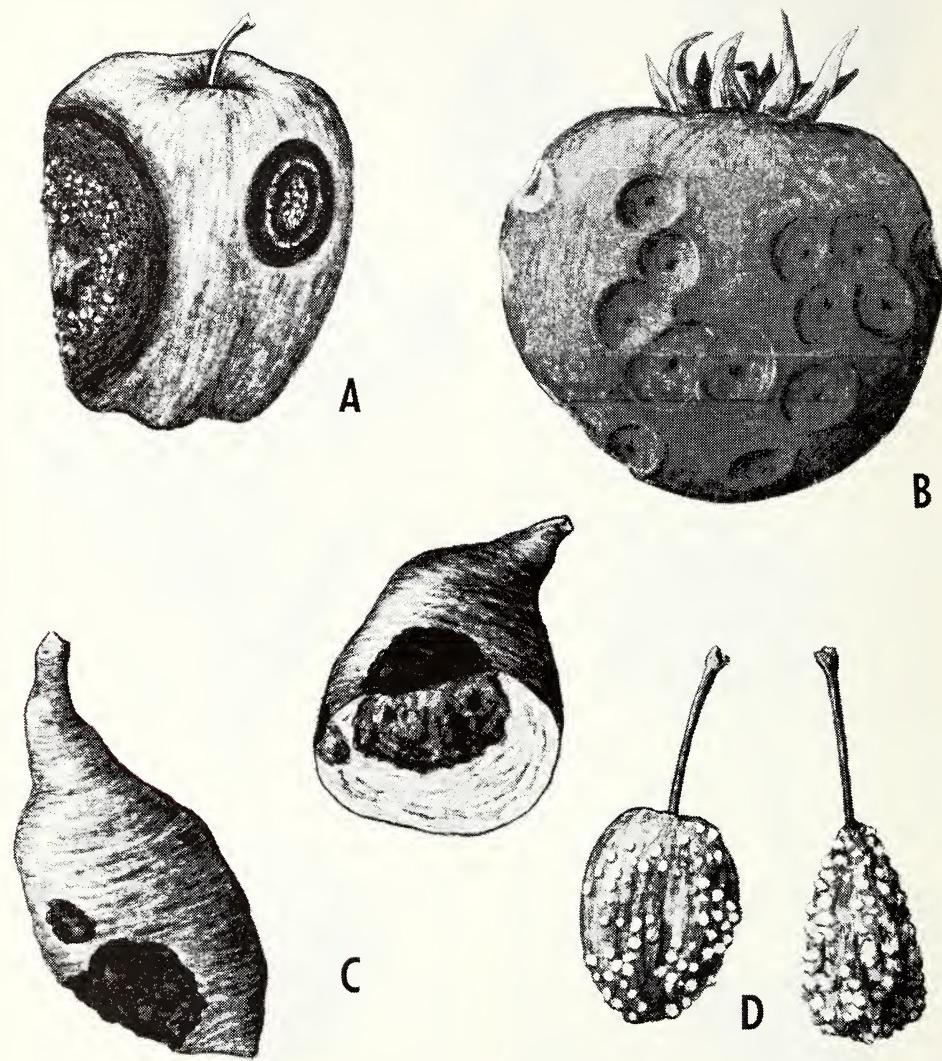


Fig. 46. Fruit rots. A. Bitter rot of apple, B. Tomato anthracnose, C. Black rot of sweetpotato, D. Brown rot of plum.

lemon, lettuce, lime, loquat, mock-cucumber, mountain-ash, mulberry, muskmelon, nectarine, okra, olive, onion, orange, palms, parsnip, pea, peach, peanut, pear, pea-tree, pecan, pepper, persimmon, plum, pomegranate, potato, pumpkin, pyracantha, quince, radish, raspberry, rollinia, rutabaga, snowberry, squash, strawberry, sweetpotato, tomato, turnip, walnut, watermelon, yam, and yautia.

Control: Mulch vegetables to keep fruit off soil. Follow spray or dust programs for vegetables and fruit. Control insects which transmit disease organisms and provide entrance wounds. Use malathion plus methoxychlor or malathion plus DDT. Promptly collect and burn (or eat) spotted and rotting fruit. Guard against wounding fruit and vegetables from harvest through the storage period. Store only sound, blemish-free fruit and vegetables at the recommended storage temperature and humidity. Check with your extension horticulturist. Treat seed of vegetables and flowers as given under the plant involved and in Table 13 in the Appendix. Plant only high-quality seed. Resistant varieties are available for some plants.

(33) **Smut** Flower parts or seed may break open to release a black, powdery mass. See (11) Smut.

D. Root and Bulb (Corm) Diseases

(34) **Root Rot, "Decline," Cutting Rot** Symptoms variable. Plants may gradually lose vigor, becoming sickly or yellowed and stunted. Plants tend to wilt or die back and do not respond normally to water and fertilization. Young plants wilt and collapse. Affected plants are more subject to wind damage — may blow over or lodge. Root rot is often difficult to diagnose because the trouble is hidden from view. Roots decay. May be covered with mold growth, and be brown, black, white, or gray in color. Decay may be water-soaked, mushy, spongy, or firm. Easily confused with wilts, bacterial soft rot, crown rots, root-feeding insects, or nematodes. Nematodes often provide wounds by which root-rotting fungi and bacteria enter. Usually most serious on annual plants in cold, wet, poorly drained soils. See under (15) Wilts, (21) Crown Rot, (35) Clubroot, (36) Bulb Rot, and (37) Root-knot.

In the southwestern states (Oklahoma and Texas to southeastern Utah, Nevada, and California) a widespread soil fungus (*Phymatotrichum*) causes a disease known as Texas or Cotton Root Rot. Over 1,700 kinds of plants including fruit and shade trees, shrubs, flowers, and vegetables are attacked from midsummer on. *Phymatotrichum* often kills plants in more or less circular patches, up to an acre or more in diameter. A firm brown rot of the lower stem and roots occurs. Affected roots may be covered with a dirty-yellow weft of mold and brown or black bodies (sclerotia). The fungus is only found in alkaline soils (pH 7.3 and above). If you live in the Texas Root Rot area, contact your state or extension plant pathologist for a listing of resistant plants and other control measures which are effective against this disease.

Plants Attacked: Practically all plants.

Control: Plant in a well-drained, well-prepared soil high in organic matter (page 16). Practice a systematic crop rotation. Burn tops of annual plants after harvest. Dig up and burn affected garden plants. Sterilize soil for seedbeds and house plants (see pages 437-44 in the Appendix). Start seed of very susceptible plants in a sterile or uninfested medium (e.g., vermiculite, sifted sphagnum moss, perlite or soil). Treat seed before planting. See Table 13 in the Appendix. Avoid overcrowding and overwatering in the seedbed. Keep perennial plants growing vigorously through proper fertilization, watering, cultivating, and pruning. Avoid close and deep cultivations. Practice balanced soil fertility. Keep down weeds. If possible, do not replant trees in the same location where previous woody plants have died from Root Rot. Applying a soil drench of Fumazone, Nemagon, or VC-13 Nemacide around living plants may be beneficial if root-feeding nematodes are present in large numbers.

(35) **Clubroot** Attacks crucifers. Plants may not head, but remain stunted and sickly. Often plants wilt on hot, dry days and partially recover at night. Outer leaves may turn yellow and drop. The roots form a mass of small to large, distorted, club-shaped swellings. They later rot from secondary organisms.

Plants Attacked: Alyssum, broccoli, Brussels sprouts, cabbage, candytuft, Chinese

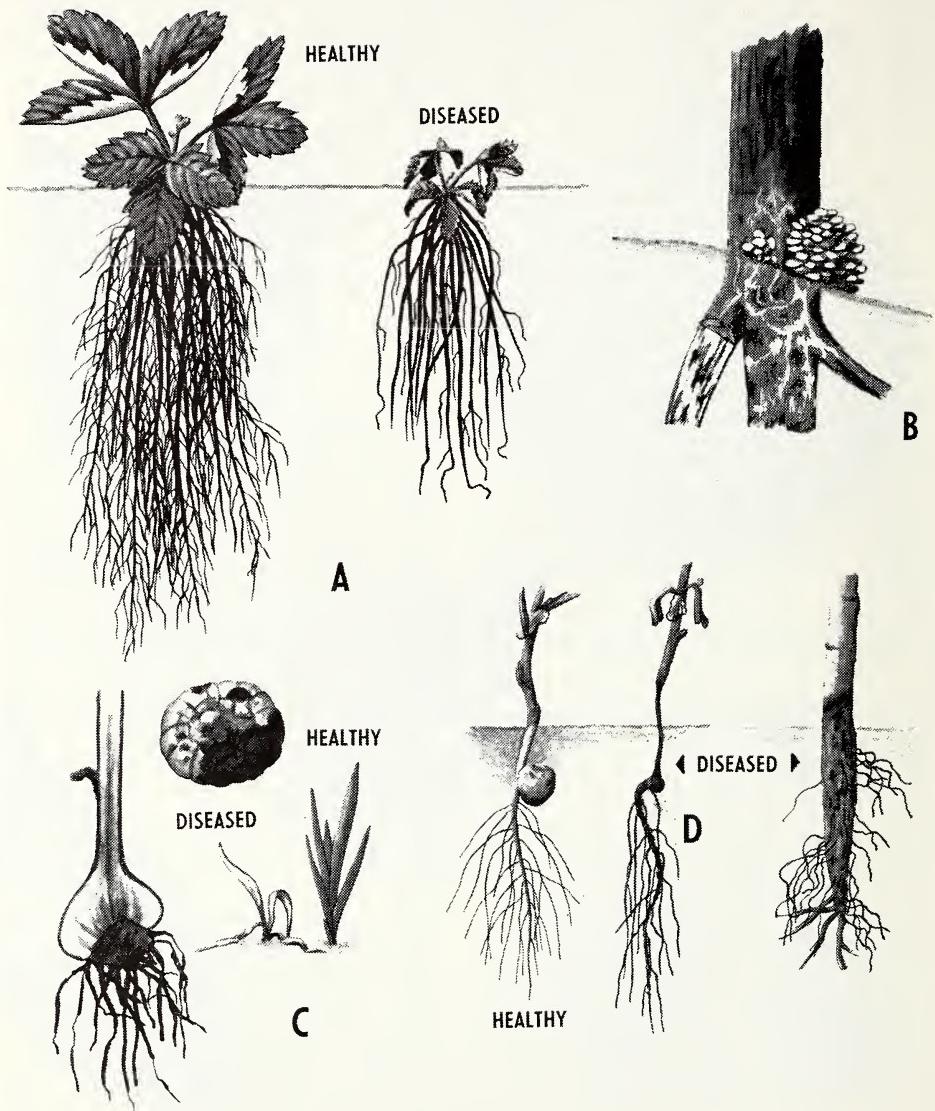


Fig. 47. Root rots. A. Black root rot of strawberry, B. Armillaria root and wood rot, a common disease of woody plants, C. Root and corm rot of gladiolus, D. Root and stem rot of pea.

cabbage, cauliflower, collards, dames-rocket, erysimum, garden cress, honesty, horseradish, kale, kohlrabi, mustard, peppergrass, radish, rockcress, rutabaga, sea-kale, stock, sweet alyssum, turnip, and wallflower.

Control: If practical, apply enough hydrated lime to the soil about 6 weeks before planting to reach a pH of 7.2 or higher. Where possible, either avoid or drain wet soils. Plant disease-free seedlings in sterilized soil (pages 437-44), water seedbed with a 1:2,000 solution (1 ounce in 15 gallons of water) of mercuric chloride (see page 85 for precautions) or work Terraclor (PCNB) into the top 4 to 6 inches of soil about 2 weeks before

cayed. Usually associated with nematodes, bulb mites, and insects. Decay often starts at bulb base (root or basal plate, bottom of stem) and progresses upward and outward. Spots may also develop on the side or neck of the bulb. There may be little external evidence of rot although bulbs may be lightweight and soft or punky. Rot usually progresses in storage, especially if the temperature and moisture are not controlled. See (29) Bacterial Soft Rot, (32) Fruit Rot, (34) Root Rot, and (38) Bulb Nematode.

Plants Attacked: Acidanthera, allium, amaryllis, chives, colchicum, crocus, freesia, garlic, gladiolus, glory-of-the-snow, grape-hyacinth, hyacinth, iris, ixia, leek, lily, lily-of-the-valley, lycoris, narcissus, onion, shallot, snowdrop, snowflake, squill, tigerflower, tritonia, tuberose, tulip, and zephyranthes.

Control: Plant or store disease-free bulbs (and corms) free of rot spots. Cure bulbs thoroughly and as rapidly as possible after digging. Sort carefully at digging time, before storage, and again just before planting. Treat bulbs or corms before planting. See under the plant involved and Table 13 in the Appendix. Rotate crops or plant in sterilized, well-drained soil (pages 437-44).

(37) Root-knot, Root Gall, Cyst Nematode

Nematode-infested plants usually lack vigor, are often stunted and yellowish. May resemble soil deficiency symptoms, crown rot, root rot, etc. Severely infected plants may wilt in dry weather but recover at night for a time, then may wither and die. Small to large swellings, galls or knots, develop on the roots which are more or less round, or long and irregular—cannot be broken off, like the nodules on legume roots. Roots may become “beaded,” swollen, or greatly distorted. Widespread and damaging in many southern soils, especially light, well-aerated ones. Both yield and quality are reduced. Primarily an indoor problem in the most northern states, although there is one species of root-knot which is found mostly in northern states. Root-knot is distributed in infested nursery stock, in root crops, and soil transported on shoes, sacks, crates, tools, or equipment. Root-knot and cyst nematodes may increase the severity of certain wilt diseases and root rots.

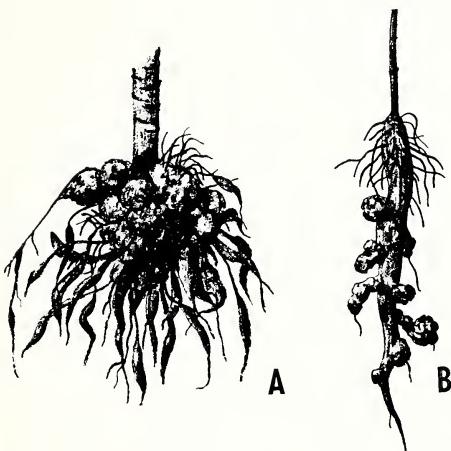
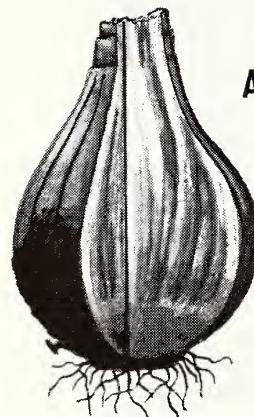


Fig. 48. Clubroot. A. Cabbage, B. Mustard.

planting. Apply broadcast or as a band. Follow the manufacturer's directions. Add Terraclor to the transplanting water (see under Cabbage). Varieties differ in resistance. Rutabagas, most turnips, peppergrass, horseradish, kale, and garden cress are usually very resistant. Practice a long rotation, keeping out all cruciferous weeds (e.g., charlock, wild radish, wild mustards, pennycress, shepherds-purse, yellow-rocket, or wintercress). Collect and burn crop debris after harvest.

(36) Bulb (Corm) or Rhizome Rot Shoots fail to emerge or are sickly with yellow leaves which die back progressively from the tips. Roots often discolored and de-



A



B

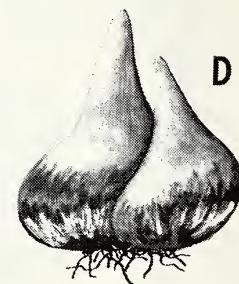


SOFT
MEALY ROT

SCALE TIP ROT

C

BROWN
SCALE ROT



D

Fig. 49. Bulb rots. A. Narcissus, B. Onion, C. Lily, D. Tulip.

Plants Attacked: Practically all except certain grasses, grains, and weeds.

Control: Where practical, sterilize (fumigate) the soil or rooting medium using heat or chemicals (e.g., D-D, Dordon, EDB, chloropicrin, Telone, Vapam, V.P.M., or Mylone; see page 89 and pages 437-44 in the Appendix). The soil temperature at treating time should generally be 60° to 65° F. or above. The soil is commonly fumigated in the fall after harvest while the soil is still warm. Nemagon, Fumazone, and VC-13 Nemacide may be used around many types of infested living plants. Follow the manufacturer's directions carefully. Plant disease-free nursery stock and certified transplants of cabbage, tomato, and certain other plants. See (34) Root Rot.

(38) Bulb Nematode, Ring Disease, Onion

Bloat Symptoms variable. Usually plants are stunted with the foliage twisted, crinkled, and yellow. Petioles are often swollen and cracked. The main roots may be discolored and develop furrows and cracks.

1. *Hyacinth* — Yellow to brown flecks or blotches on the leaves which become twisted, short, and split. Flower stalks are stunted and flowers are malformed. Bulb scales become thickened and turn brown. Cut bulbs are the same as for *Narcissus*.
2. *Narcissus* — Small, yellowish, blisterlike swellings on the leaves. Badly infested bulbs produce only a few twisted and bent leaves or none at all. Infested bulb scales are brown. When infested

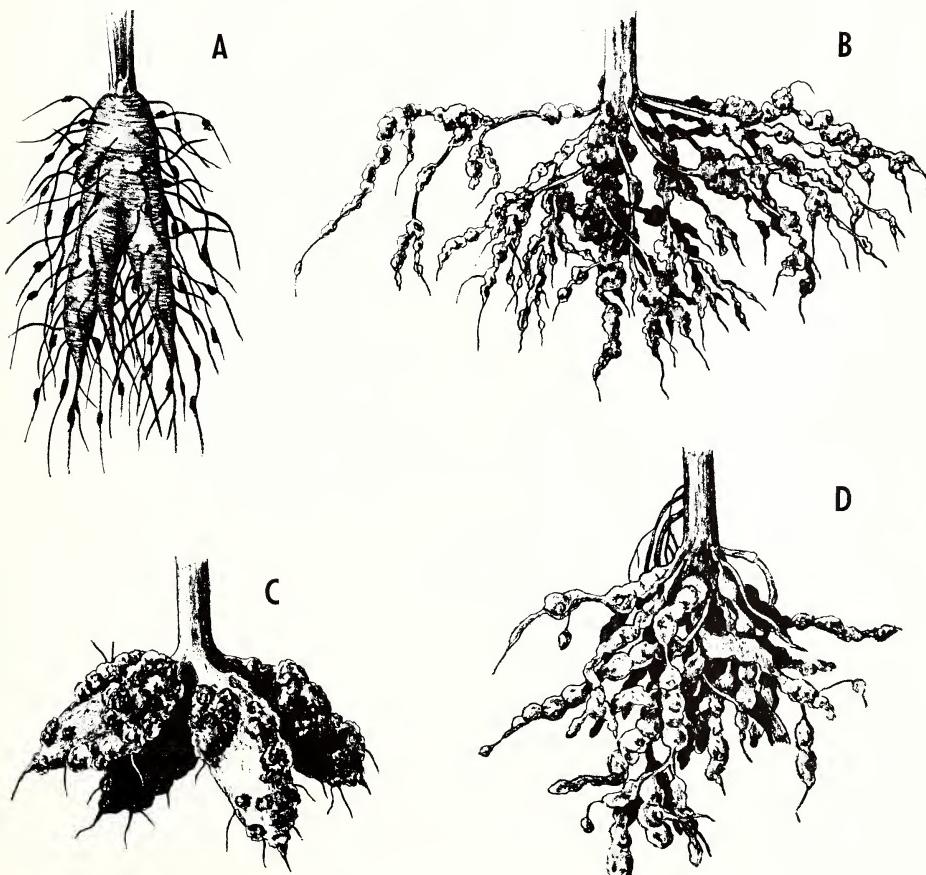


Fig. 50. Root-knot. A. Carrot, B. Watermelon, C. Dahlia, D. Tomato.

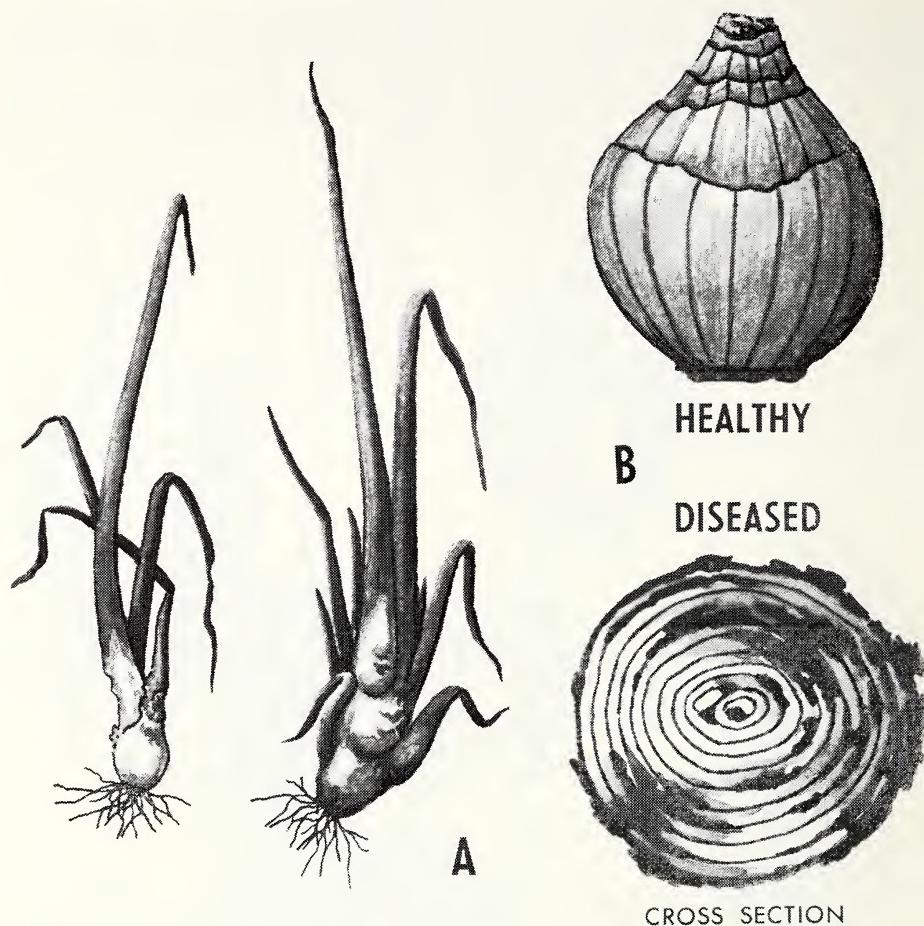


Fig. 51. Bulb nematodes. A. Onion bloat, B. Ring Disease of hyacinth.

bulbs are cut through, one or more dark rings are evident.

3. *Onion* — Seedlings dwarfed, twisted, and abnormally white. Young bulbs are swollen and misshapen (bloated), and become soft.

Nematodes are spread by tools, running water, animals, infested soil, and planting infested bulbs.

Plants Attacked: Chives, collomia, dahlia, galtonia, garlic, glory-of-the-snow, grape-hyacinth, hyacinth, iris, lycoris, narcissus, onion, parsley, shallot, squill, sweetpotato, tigerflower, and tulip.

Control: Destroy infested plants. Plant disease-free bulbs or seeds in sterilized or

clean soil (see pages 437-44 in the Appendix). Avoid heavy, poorly drained soil. Soak fully dormant narcissus and hyacinth bulbs in hot water and formaldehyde. See Daffodil and Tulip. Collect and burn tops, infested bulbs, and other crop debris in the fall. Practice a 3-year or longer rotation with noninfected crops. Keep down weeds.

E. Parasitic Flowering Plants

(39) **Mistletoes** There are two general types: American or true mistletoes and dwarf mistletoes.

American or True Usually leafy, evergreen tufts of shoots with yellow to dark green,

leathery leaves. White, yellow, or pinkish to red berries are produced. The sticky seeds are easily spread by birds and animals. Infections commonly occur on tree branches after birds wipe the seeds from their beaks. The leafy masses of American or true mistletoes may be up to 3 feet in diameter. They are most conspicuous after the leaves drop in the fall.

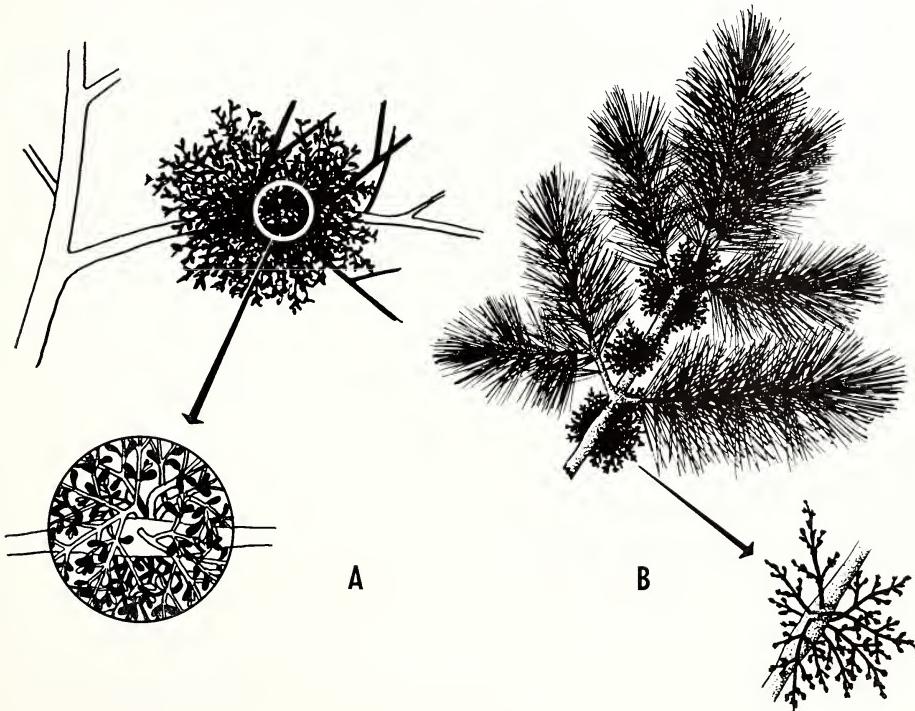
Found as far north as Oregon, where winters are not severe. Only relatively young branches are attacked. Tree branches beyond the mistletoe may be stunted, even die. Once established, the mistletoe may live as long as the tree it feeds upon. This is the mistletoe used for Christmas greens.

Dwarf Perennial, scaly-leaved, simple or branched shoots on conifers. The stems vary from yellow to brown to olive-green in color. Berries are olive-green to dark blue. The sticky seeds are explosively shot out of the fruit. This type of mistletoe is

often less than an inch in diameter, but may be up to 8 inches. Dwarf mistletoes may seriously stunt or deform the growth of evergreen trees, especially seedlings and young trees. Conspicuous witches'-brooms are formed in the crown or spindle-shaped swellings (later cankers) in the trunk. Branches or even entire trees may be killed. Most common in the western states in forested areas.

Plants Attacked: Acacia, alder, apple, ash, beech, birch, black gum, black locust, buckeye, camphor-tree, chinaberry, cherry, cherry-laurel, cypress, dogwood, Douglas-fir, elaeagnus, elm, fir, forestiera, frangipani, hackberry, hawthorn, hemlock, Hercules-club, hickory, honeylocust, horsechestnut, incense-cedar, juniper, larch, linden, locust, manzanita, maple, oak, Osage-orange, osmanthus, paper-mulberry, parkinsonia, pear, pecan, persimmon, pine, planetree, plum, poplar, prickly-ash, redcedar, sassafras, smoketree, soapberry, sophora, spicebush, spruce,

Fig. 52. Mistletoe. A. American or true mistletoe on apple, B. Dwarf mistletoe on pine.



sugarberry, sweetgum, sycamore, tamarack, trumpetvine, tupelo, walnut, and willow.

Control: Cut off young infected branches a foot or more beyond any evidence of the mistletoe. For older branches cut out the bark and wood a foot or more away from each infection. Apply disinfectant to the wound surface and paint with tree wound dressing (page 25). If an evergreen trunk is infected with dwarf mistletoe, the tree should be cut down whenever practical.

(40) Dodder, Strangle Weed, Love Vine, Gold Thread Orange to yellow, "leafless," slender, twining vines which are parasitic on a wide range of garden plants. Occurs in tangled patches which take on a yellowish-orange color as the dodder chokes out the vigor of garden plantings.

Control: Plant clean vegetable and flower seed free of the rough, flat-sided, gray to reddish-brown, dodder seed. When dodder is found on garden plants, carefully remove and burn all infested plants before the dodder forms seeds. Locate patches early, before the plant spreads. When breaking new soil suspected of being dodder-infested, fumigate it before planting by using a soil fumigant (see next section and pages 439-44 in the Appendix). Areas known to be heavily infested with dodder seed should be planted to resistant plants, e.g., grass, corn or small grains for at least two years in succession. Where this cannot be done, the use of a soil fumigant is advisable. A



Fig. 53. Dodder on aster.

glove, moistened with dilute 2,4-D spray and dried, may be used to stroke dodder plants strangling a valuable plant. If any dodder survives after three days, repeat the treatment. Check with your county agent, extension weed specialist, or horticulturist for details.

SECTION 3

“What Can I Do About It?”**MEASURES**

Plant adapted varieties and types of plants	82
Buy disease-free planting stock	82
Treat the seed	82
Control damping-off	82
Plant in a well-prepared and well-drained seedbed . . .	82
Follow a recommended crop rotation	83
Pasteurization of infested soil and compost	83
Control weeds	83
Control insects, mites, and rodents	83
Avoid deep and close cultivations	83
Sanitary measures are important	83
Changing a cropping practice	83
Store only sound, dry fruits and	
Destroy or remove alternate hosts of rust diseases . . .	84
vegetables	84
Apply protective fungicides .	84

MATERIALS

What Is a Fungicide?	84
Protective fungicides	84
Eradicant fungicides	84
Chemotherapeutants	84
Modern Fungicides	84
Other Useful Fungicides	85
Karathane	85
Mercuric chloride	85
Terraclor	85
Fixed copper fungicides . . .	88
Bordeaux mixture	88
Sulfur products	88
Phaltan	88
Antibiotics	88
A. Streptomycin	88
B. Acti-dione	89

Phenyl mercury materials . .	89
Broad-spectrum lawn fungicides	89
Chemical Soil Treatments (fumigants and temporary soil sterilants)	89
Safety Precautions When Handling Pesticides	89
Measuring Apparatus	90
When Spraying or Dusting . .	90
Multipurpose Sprays and Dusts	91
For vegetables, fruit, flowers, trees, and shrubs	91
"Shot-gun" Soil Drench	92
To Spray or To Dust?	92
EQUIPMENT	
Sprayers and Dusters	92
A. Sprayers	92
Household sprayers . .	93
Compressed air sprayers	93
Knapsack sprayers . .	95
Slide pump or trombone sprayers	95
Wheelbarrow, cart, and barrel sprayers	95
Garden hose sprayers .	95
Small power sprayers .	98
Maintenance of Sprayers	100
B. Dusters	100
Plunger type dusters . .	100
Small bellows, crank, or rotary-fan dusters . .	100
Knapsack dusters	100
Small power dusters . .	104
* * *	
Maintenance of Dusters	104
Spreaders, Stickers, and Wetting Agents	104
Fungicide Manufacturers and Distributors Plus Leading Spraying and Dusting Manufacturers	104

Once a plant problem has been diagnosed as a disease (see also Section 4), the next question is, "What can I do about it?" When a disease has progressed sufficiently to be easily recognized, it is often too late to start a spray or dust control program. Prevention and protection are usually the answer. Start before the disease appears. Tree surgery, however, is useful as a curative measure in the control of many cankers, blights, and decays of woody plants.

Successful disease control should start with the purchase of the best seed or planting stock available and should continue in the seedbed, through the season in the field, and even after harvest until the product is completely disposed of. There is much more to disease control than just dusting and spraying.

A number of different practices may be needed to help keep diseases in check. These include:

Plant adapted varieties and types of plants recommended by your state agricultural experiment station, cooperative extension service, and reputable seedsmen or nurserymen as being adapted to your area. Such varieties should include those having resistance to common diseases, plus possessing other desirable horticultural qualities. Unfortunately, resistant types are often less valuable because of some undesirable quality (e.g., poor foliage, inferior flowers or fruit, low yield). There are different degrees of resistance varying from tolerance or partial resistance to complete immunity.

Progress with control by resistant varieties is hindered because parasitic organisms mutate or otherwise produce new races which attack varieties which were formerly resistant or immune. Certain fungi, bacteria, and viruses are known to have many different physiologic races or strains.

Buy disease-free planting stock from a reputable nursery whose stock is carefully checked at least once each season by experienced nursery inspectors. This insures you of comparative freedom from damaging insects, mites, and diseases. If available, buy certified disease-free seed, propagating material, or plants. Disease-free seed is often grown in arid parts of the western United States, under irrigation, where many diseases are unknown

(e.g., black rot and blackleg of cabbage, bean anthracnose and pea blights). Use seed, bulbs, corms, tubers, cuttings, or other plant parts, *only* from healthy plants.

Treat the seed of most flowers and vegetables against seed rot and damping-off by dusting the seed lightly with thiram, captan, or chloranil (see Table 13 in the Appendix) before planting. Follow the manufacturer's directions. Seed can be treated in small packets or in larger quantities using Mason jars. See page 427 in the Appendix. Seed treatment is good insurance for increased stands and bigger yields, especially if the soil is cold and wet after planting.

Seeds, bulbs, corms, roots, and rhizomes may be disinfected by hot water or mercury which kills organisms (bacteria, fungi, nematodes) on the surface as well as within. See Table 13 in the Appendix. Care should be taken with small seeds which are more readily injured by disinfectants than larger seeds.

Control damping-off. Occasionally captan, ferbam, zineb, phaltan, thiram, Pano-drench, or Semesan, 1 to 2 tablespoons in a gallon of water, applied at the rate of $\frac{1}{2}$ to 1 pint per square foot, checks the advance of damping-off, root and crown rots. Terraclor is also useful for certain soil-borne fungi, especially those that produce sclerotia. Before soaking the infested area with the fungicide, the diseased plants and about 6 inches of surrounding soil should be removed. The manufacturer's directions should be carefully followed. Do not use mercury-containing fungicides (e.g., Semesan, Pano-drench) in confined areas or on such susceptible plants as pansy, petunia, violet, rose, and snapdragon.

For a good multipurpose "shot-gun" soil drench, see page 92.

Plant in a well-prepared and well-drained seedbed, at times most suitable for your area. Follow the planting instructions and cultural practices published by your state agricultural experiment station and cooperative extension service and those given in nursery and seed catalogs. These instructions should include information on seedbed preparation, depth and rate of planting, spacing for efficiency and care of seedlings.

Follow a recommended crop rotation that excludes the same or closely related crops in the same garden area for 3 or 4 years or more. Most disease-causing organisms persist in the soil, or in decaying crop debris, from one year to the next. A proper rotation "starves out" many of these organisms. The fungi causing clubroot of cabbage and fusarium wilts, for example, can live almost indefinitely in the soil without their favorite host plants being present. Some disease-causing organisms can remain alive through a compost pile or passage in the digestive tract of farm animals.

Pasteurization (usually called sterilization) of infested soil and compost is often an important control practice. See pages 437-44 in the Appendix regarding when and how to disinfest soil using heat or chemicals (fumigants). All plant-parasitic organisms are killed by heating the soil to a temperature of 180° F. for 30 minutes.

Control weeds (by cultural or chemical means), especially perennials and winter annuals. Weeds are important reservoirs of insects, viruses (e.g., especially mosaics and aster yellows) and other disease-producing agents. Viruses can easily be carried to nearby garden plants by insects (e.g., leafhoppers, aphids, thrips, grasshoppers, and whiteflies) and mites. Weeds also decrease air circulation and slow normal drying of the foliage following wet periods. This leads to more severe injury from leaf spots, blights, and mildews. The serious drain of plant nutrients and water from the soil by weeds is well-known to all gardeners. Check with your county agent or extension weed specialist regarding the latest weed control recommendations.

Control insects, mites, and rodents. Many diseases are spread largely or entirely by insects and mites. Most foliage-feeding insects and mites can now be controlled by using a multipurpose spray or dust containing malathion plus methoxychlor, DDT, lindane, Sevin, rotenone, or related materials. Excellent insecticides for controlling underground-feeding insects contain aldrin, dieldrin, or chlordane. If insect, mite, and rodent feeding could be prevented, losses from fruit rots, wood decays, root and crown rots, certain wilts

and foliage diseases could be materially decreased. Check with your county agent or extension entomologist regarding the latest insect and rodent control recommendations.

Avoid deep and close cultivations. Cultivator wounds weaken plants and provide easy entrance for fungi and bacteria-producing root and crown rots, certain wilts, root rots, and crown gall.

Sanitary measures are as important in keeping plant diseases in check as they are for animal and human diseases. Collect and burn infected plants or plant parts as they become infected. A disease may start in one or several plants and then spread throughout a garden when conditions (moisture, right temperature) are favorable. Destroy (rogue) the first infected plants or plant parts as soon as found. This is very important with certain virus diseases where *entire* plants should be destroyed. Burn tops after harvest is over or plow under such debris cleanly. Sanitary measures are equally important in controlling insect and mite pests. Avoid transferring bacteria, fungi, mites, and insect eggs on hands, clothing, or tools. Tools may be disinfected by dipping in 70 per cent denatured alcohol, 5 per cent formaldehyde, household bleach, or a 1:1,000 solution of mercuric chloride (page 85). Hands should be scrubbed with soap and hot water before handling healthy plants. Work among plants only when they are dry.

Sanitary measures are often the only ones needed in the home garden. But it helps if you can convince your neighbors to do likewise! Pruning of infected twigs, branches, and shoots helps to control many diseases. But prune with discretion. Excessive pruning may stimulate excess shoot growth which is often more susceptible to reinfection. Prune at least several inches below any sign of infection.

Changing a cropping practice is often a good method of disease control. Staking tomato vines, instead of letting them lie on the ground, reduces losses from fruit rots. Pruning to open up trees and shrubs lets in sun, increases air circulation, and hence reduces the chance of foliage diseases getting a foothold. Shallow planting often means a better stand of seedlings under cold, wet conditions. Aeration of

the soil, application of a suitable fertilizer, planting to escape migrations of leaf-hoppers, aphids, or other pests, and watering during drought periods are other means of escaping injury from certain diseases.

Destroy or remove alternate hosts of rust diseases. See (8) Rust under General Diseases. Which type of plant is destroyed will depend on such factors as the number and value of the plants involved. Many such plants can now be protected against rusts by the proper and timely application of fungicides.

Store only sound, dry fruits, and vegetables free of cuts, bruises, rot, insect or rodent injuries. Requisites of good storage are the proper temperature, aeration, humidity, (and moisture content, where applicable) plus cleanliness (page 172). If in doubt concerning the recommended storage conditions for your garden produce, check with your county agent or extension horticulturist. The USDA Farmers' Bulletin No. 1939, *Home Storage of Vegetables and Fruits*, covers this subject in detail. For additional information on the most favorable temperature and approximate length of the storage period for cut flowers, rhizomes, tubers, roots, bulbs, corms, and nursery stock, see a book such as the USDA Handbook No. 66, *Commercial Storage of Fruits, Vegetables, Florist, and Nursery Stocks*.

Apply protective fungicides. This means applying the right chemicals in the right way at the right time and in the right concentration. If this is done, there will be no danger of damaging tender plants or poisonous pesticides remaining on ripening fruits and vegetables.

It usually pays to follow a regular preventive schedule. Applications should generally be made every 3 to 7 days in wet weather and at 10- to 14-day intervals if the weather is dry. If rains of an inch or more wash the fungicide away, re-apply. Insecticides should be applied on a planned, protective schedule every 7 to 10 days, before large numbers of insects appear and damage occurs. For certain insects closer spacing of sprays is needed.

WHAT IS A FUNGICIDE?

A fungicide is any chemical which protects plants against disease-producing

fungi that land by chance on the plant, as spores or mycelium.

Fungicides can be conveniently divided into three groups, according to their action.

Protective fungicides are applied as foliage sprays or dusts and as seed or soil treatments to keep disease-causing fungi from entering plants. These materials will provide protection, but will not (1) kill fungi established within a growing plant or seed (Exceptions are the powdery mildews which are superficial and largely on the surface of plants. These mildews can be killed by surface dusts or sprays, after infection has occurred, without injury to the host plants.), (2) protect against disease organisms entering through the roots such as root rots, wilts, and clubroot, (3) control bacterial diseases — since most fungicides are poor bactericides, (4) protect against viruses, which are frequently injected into plants by insects, and (5) control nematodes.

Most fungicides in use today (e.g., captan, zineb, maneb, ferbam, thiram, copper- or sulfur-containing) are protective in nature. Foliage sprays or dusts should be applied before wet periods when the great majority of infections occur.

Eradicant fungicides are applied as foliage sprays, seed treatments or soil drenches to kill or check disease-causing fungi after they have penetrated into plants and become established. Examples are phenyl mercury materials used by commercial apple growers to "burn out" apple scab infections, and the mercury-containing chemicals used on certain types of seed, bulbs, tubers, and rhizomes, to kill organisms under the seed coat or within propagative plant parts. These fungicides have limited uses and are often dangerous to use on green foliage.

Chemotherapeutics are chemicals absorbed and distributed within the plant to control certain diseases. Very few chemicals now available work in this way, but chemotherapy is currently a very promising field of research.

MODERN FUNGICIDES

In the past few years a great many new fungicides have been introduced. These chemicals are rapidly replacing such old standbys as bordeaux mixture, other copper-containing materials, lime-sulfur and

wettable or paste sulfur fungicides. Many of these older materials were messy to handle, corrosive to spray equipment, caused injury to plants and reduced both the quality and quantity of the crops they were designed to protect. Unfortunately, many garden supply stores, hardware stores, and drugstores do not stock modern fungicides. If you can't get some of the chemicals mentioned in this book or those recommended by your state cooperative extension service and agricultural experiment station, check with your county extension office or the list of names and addresses of leading fungicide manufacturers and distributors at the end of this section. If you can't get a pesticide you want locally you can always write directly to the chemical manufacturer or distributor.

The chemical names (called active ingredients) of the new fungicides, printed on many package labels, are difficult to remember or pronounce. Fungicides are marketed under a bewildering assortment of trade names. To relieve confusion, a set of common names has been officially adopted and is being increasingly used on package labels in place of the more complicated chemical names. Table 1 summarizes the common names, active ingredients, trade names, major distributors, and principal uses of the most common modern fungicides. This listing is necessarily incomplete as there are over 50,000 pesticides now registered by the Pure Food and Drug Administration in Washington, D.C.

Where specific trade names are mentioned in this book, it is to be understood they are not mentioned to the exclusion of other similar and competitive products. They are simply representative of the most generally available products in the United States.

The most useful modern fungicides for the home gardener are captan, zineb, maneb, Karathane, Terraclor (PCNB), and mercuric chloride.

OTHER USEFUL FUNGICIDES

Karathane contains dinitro phenyl crotonate as the active ingredient. It is *specific* for the control of powdery mildews. Sold as Karathane-WD or Karathane L (Rohm & Haas). Karathane has replaced sulfur in many multipurpose sprays and dusts. Compatible with practically all

fungicides, insecticides, and miticides in these combination mixtures (page 91). Do not use in hot weather (above 85° F.). Apply when the foliage will dry rapidly. Used normally at the rate of $\frac{1}{2}$ to $\frac{2}{3}$ teaspoonful in a gallon of water.

Mercuric chloride is also known as corrosive sublimate and bichloride of mercury. Used as a general disinfectant, soil drench, and dip treatment. Controls rots of gladiolus, calla, canna, and iris besides killing disease-causing organisms carried inside pepper, cucumber, melons, cabbage, and other seed. The dipping time in mercuric chloride varies from 5 minutes to 2 hours or longer, depending on the plant part treated.

Mercuric chloride is a *caustic, deadly poison* and should be handled with caution. It is usually sold by pharmacists as a white powder or in the form of tablets. Commonly prepared to make a 1 in 1,000 solution by dissolving 1 ounce in $7\frac{1}{2}$ gallons of water, or one 7.3 grain tablet in a pint of water. Handle only in non-metallic containers such as wood, glass, enamel, or earthenware. Dissolve the chemical in a small amount of hot water and add to the rest of the water. Seeds, bulbs, and corms should be washed in clear, running water for 5 to 10 minutes after treating. Dry, then plant. See "Seed Treatment Methods and Materials" in the Appendix.

Mercuric chloride and mercurous chloride are combined in several useful lawn fungicides — Calo-clor, Calocure (Mallinckrodt), Fungchex, and Woodridge Mixture "21."

Terraclor contains PCNB (pentachloronitrobenzene). Is a long-lasting soil fungicide. Sold as a 75 per cent wettable powder, a 25 per cent emulsifiable concentrate, or 10, 20, and 40 per cent dusts by the Olin Mathieson Corp. and the Stauffer Chemical Co. Controls various soil-borne root, stem, and crown rots of flowers, vegetables, and ornamentals, club-root of cabbage, potato scab and scurf, pink rot of celery, and damping-off of many plants. See Table 14 in the Appendix. We will see more of this chemical and other soil fungicides in the future. Often mixed with captan (Terracap and Orthocide Soil Treater "X"), ferbam, thiram, or phaltan, and applied as a dust or spray in the seedbed to control root

TABLE I
MODERN FUNGICIDES

Common Name	Active Ingredient	Trade Names and Distributors	Principal Uses and Remarks
Captan	N-trichloromethyl-thiotetrahydro-phthalimide	Captan 50-W, Captan 75 Seed Protectant, Captan-Dieldrin 60-15 Seed Protectant, Captan Garden Spray, Captan 80 Spray-Dip (Staudfer), Orthocide 50 Wettable, Orthocide Fruit and Vegetable Wash, Orthocide 75 Seed Protectant (California Spray-Chemical Corp.)	Excellent, safe fungicide for fruit, ornamentals, and vegetables to control leaf spots, blights, fruit rots, etc. Seed protectant for vegetables, flowers and grasses. Post-harvest dip for fruits and vegetables. Soil drench to control crown rot and seedling blights. Widely used in multipurpose sprays and dusts.
Chloranil	Tetrachloro-p-benzoquinone	Spergon, Spergon Wettable, Spergon Seed Protectant (U.S. Rubber), Spergon Spray Powder (Niagara and General Chem.), Niagara Seed Protectant, etc.	Seed and bulb treatment for flowers, vegetables, and grasses. Soil drench for crown rot of flowers. Corm and bulb dip for flowers. Sprays and dusts for certain foliage diseases.
Dichlone	2,3-dichloro-1,4-naphthoquinone	Phygon, Phygon-XL, Phygon Seed Protectant (U.S. Rubber), Phygon-XL Micronized (Pittsburgh Plate Glass), Niagara Phygon, Phygon Wettable Powder (Gen.), etc.	Seed treatment for certain vegetables and flowers. Spray for certain blights and fruit rots of vegetables and fruits. Soil drench to control damping-off. Treat as directed.
Ferbam	Ferric dimethyl-dithiocarbamate	Fermate Ferbam Fungicide (Du Pont), Karbam Black (Sherwin-Williams), Carbamate (Niagara), Ferbam (Calif. Spray), Orchard Brand Ferbam (Gen.), Coronate (Pittsburgh Plate Glass).	General fungicide to control many foliage diseases of flowers, trees, shrubs, and fruits. Soil drench to control damping-off and seedling blights. Used in some multipurpose fruit sprays.
Maneb	Manganese ethylene bisdithiocarbamate	Manzate Maneb Fungicide, Manzate 75 (Du Pont), Dithane M-22 (Rohm and Haas), etc.	General fungicide to control foliage diseases of vegetables, flowers, trees, some fruits. Very useful for tomato and potato. In multipurpose sprays.

Thiram (TM TD)	Tetramethyl thiuram disulfide	Tersan 75, Thylate, Arasan 75, Delsan A-D (Du Pont), Thiram 50 Dust (U.S. Rubber), Panoram 75 (Morton), etc.	Seed and bulb treatment on vegetables, flowers, and grasses. Controls certain lawn diseases. Soil drench for crown rot and damping-off.
Zineb	Zinc ethylene bis- dithiocarbamate	Dithane Z-78 (Rohm & Haas), Parzate Zineb Fungicide, Parzate C (Du Pont), Ortho Zineb 75 Wettable, Ortho 4 or 6 Dust (Calif. Spray), Stauffer Zineb (Stauffer), etc.	Excellent fungicide for vegetables, fruits, flowers, trees, and shrubs. Also useful on lawns. Soil drench to control crown rots and root rots. In many vegetable and flower multipurpose mixes.
Ziram	Zinc dimethyl di- thiocarbamate	Zerlate Ziram Fungicide (Du Pont), Karbam White (Sherwin-Williams), Z-C Spray or Dust (Niagara), Ziram (California Spray, Stauffer), etc.	General, safe fungicide. Useful for vege- tables and ornamentals, especially tender seedlings. In many vegetable and flower multipurpose mixtures.

and stem rots, damping-off, and other diseases.

Fixed copper fungicides are represented by a large group of trade names (e.g., Copper A Compound, Cuprocide, Basic Copper Fungicide, Farmrite M-53 Fixed Copper, Basi-Cop, Tri-Basic Copper Sulphate, Coposil, Spray Cop, C-O-C-S, Microgel, Tricop, Ortho-K, Tennessee "26" Copper Fungicide, Ortho Copper Fungicide "53," Copper 53, Corona 53, Micro Nu-Cop, Copper Hydro, and many others). Similar in usage to bordeaux mixture (sprays, dusts, soil drenches), except fixed coppers often do not require mixing with lime, and, thus, do less damage to plants in cool, moist weather. Fixed coppers are also easier to handle and use. Copper-containing materials are still recommended to control various blights and leaf spots of vegetables, flowers, trees, and shrubs. Materials to be used as sprays usually contain from 53 to 55 per cent metallic copper; dusts from 5 to 11 per cent.

Bordeaux mixture has largely been replaced by new fungicides which do not "burn" leaves or "russet" fruit. Bordeaux is a mixture in water of copper sulfate (bluestone or blue vitriol) and spray lime. The formula is written in figures (e.g., 4-4-50) in which the first is copper sulfate in pounds, the second number is spray lime in pounds, and the third figure is water in gallons.

For preparing small amounts of 4-4-50 bordeaux mixture, dissolve 2 ounces of copper sulfate crystals in a gallon of water. Then dissolve 2 ounces of hydrated spray lime in 2 gallons of water. Add the copper sulfate solution to the lime water. Strain the mixture into the sprayer through several layers of cheesecloth and use immediately. This makes 3 gallons of 4-4-50 bordeaux mixture.

Various dry products, ready to mix with water, are available (e.g., Acme Bordeaux Mixture, Bor-dox, Copper Hydro Bordo, and Ortho Bordo Mixture) but are generally inferior to homemade bordeaux. Bordeaux is still used to control certain fungus leaf spots, blights, anthracnose, and as a general disinfectant for storage cellars, work surfaces, and other areas. Bordeaux paint is used as a tree wound dressing (page 25).

Sulfur products are available as wettable

powders, pastes, liquids, and dusts under a variety of trade names. Twenty-five to 97 per cent wettable or colloidal sulfur makes a fine suspension in water. For most effective disease control use wettable sulfurs with an average particle size of not more than 5 to 7 microns. Sulfur dusts should be fine enough to pass through a 300 or 325 mesh screen. Sulfur is used primarily to control powdery mildews on many plants, brown rot of stone fruits, certain rusts, leaf blights, and fruit rots. May cause injury in hot, dry weather especially to sulfur-sensitive plants like viburnum, raspberry, grape, and blueberry. Sulfur is being rapidly replaced by newer fungicides.

Lime-sulfur is effective against both fungi and certain insect and mite pests. It is most useful, when properly used, as a dormant or delayed dormant spray for trees, shrubs, and fruits to control blight or anthracnose, powdery mildew, apple scab, mites, and scale insects. Use liquid lime-sulfur at the rate of one pint of concentrated lime-sulfur in 9 or 16 pints of water. Lime-sulfur is now considered too toxic to use for summer sprays. Keep it away from white paint unless you want the paint blackened!

Phaltan — A new fungicide containing N-trichloromethylthiophthalimide. A close relative of captan. Sold as Ortho Rose Garden Fungicide and Ortho Phaltan 50 Wettable (California Spray-Chemical Corp.), as Phaltan 50 Wettable and Phaltan 75-W (Stauffer), and Niagara Phaltan 50 Wettable (Niagara). Excellent for roses and other plants. Also controls many powdery mildews. Expect to see phaltan in more multipurpose mixtures in the future, especially for roses.

Antibiotics — Recently antibiotics have been widely used to control plant diseases. Antibiotics may be absorbed through plant surfaces and be distributed within the plant to check or eradicate an infection, plus protecting against other diseases becoming established. The future of these materials in the therapeutic control of certain, hard-to-control diseases is promising. We can look forward to even more useful antibiotics in the future. Two of the most widely available are:

A. *Streptomycin* — An antibacterial antibiotic sold commercially for plant use as Agri-mycin (Charles Pfizer), Phyto-

cin (Squibb, Olin Mathieson), Streptomycin Spray (Calif. Spray), Streptomycin Antibiotic Spray (Miller), Stauffer Streptomycin (Stauffer), and Agristrep (Niagara). Agri-mycin 500 (Charles Pfizer) is a mixture of streptomycin, copper, and terramycin. Agri-mycin 100 (Charles Pfizer and Chipman Chemical Co.) contains streptomycin and terramycin in combination.

Streptomycin formulations are used to control the blossom blight stage of fire blight [see (24) Fire Blight under General Diseases], bacterial spot of pepper and tomato, bacterial wilts, blights, and rots of various trees and ornamentals, and blackleg of potato.

B. *Acti-dione* — An antifungal antibiotic sold by the Upjohn Co. Effective against such diseases as powdery mildew, cherry leaf spot, certain rusts and several lawn diseases. Acti-dione is used at such amazingly low concentrations as 1 part in 1 million parts of water! Do not overdose with this chemical. Various formulations (e.g., Acti-dione BR, PM, RZ, ferrated, Actidione-captan, and Acti-dione-thiram) are sold for different purposes. Actispray (Upjohn and Niagara) is in a convenient tablet form which dissolves in water.

Other new antifungal and antibacterial antibiotics will undoubtedly be widely available in the future.

Phenyl (organic) mercury materials are useful in controlling a number of lawn diseases, certain leaf blights and spots of trees and shrubs, bulb rots, and a few fruit diseases (e.g., apple and peach scab). These materials act both as protective and eradicant fungicides. Sold as liquids: PMAS (Cleary), Puratized Agricultural Spray, Puratized Apple Spray (Niagara), Tag Fungicide or Crabgrass Killer and Turf Fungicide (Calif. Spray), Coromerc Liquid (Pittsburgh Plate Glass), Panogen Turf Spray or Pano-drench (Morton), Phenyl Mercury Lactate and 10% Phenyl Mercury Acetate (Eastern States); and as powders: Phix (Chemley) and Coromerc (Pittsburgh Plate Glass). Usually contain phenylmercury acetate (PMA), phenylmercury chloride (PMC), phenylmercury lactate (PML), phenylmercury nitrate (PMN), or phenylmercury monoethanol ammonium acetate.

Broad-spectrum lawn fungicides — Several

products are now available which control a wide range of lawn diseases. Some of these include Kromad (Mallinckrodt), Formula Z (Vaughan Seed Co.), Tersan OM (Du Pont), Ortho Lawn and Turf Fungicide (Calif. Spray), and Thimer (Cleary). Zineb also controls a number of lawn diseases.

CHEMICAL SOIL TREATMENTS

Fumigants and temporary soil sterilants are chemicals which generally break down in the soil to release a toxic gas which kills bacteria, nematodes, weed seeds, insects, and other animal life in the soil. Some are also effective fungicides. Certain fumigants move through the soil slowly. Other fast-acting ones must be confined with a tarp or other covering.

Many home gardens in the southern half of the United States are fumigated each year to control root-knot nematodes and other soil pests. See page 440 in the Appendix.

Such common fumigants as EDB (ethylene dibromide), D-D (dichloropropene-dichloropropane), Vapam or V.P.M. Soil Fumigant, and chloropicrin must be applied two weeks or more before planting to prevent serious plant injury. Apply when the soil moisture is relatively high and the soil temperature is at least 60° to 65° F., 4 inches deep. The soil around certain actively growing ornamentals and turf may be treated with the relatively safe Nemagon (Shell) and Fumazone (Dow). Other useful fumigants include Vapam (Stauffer), V.P.M. Soil Fumigant (Du Pont), allyl alcohol, and Mylone (Union Carbide).

Use these materials strictly according to the manufacturer's directions. Observe all safety precautions. For a full discussion on Soil Treatment Methods and Materials see pages 437-44 in the Appendix.

SAFETY PRECAUTIONS WHEN HANDLING PESTICIDES

There is no pesticide (any chemical which kills pests) mentioned in this book which cannot be used with perfect safety if you follow the necessary precautions. In fact the chemicals were carefully chosen not only because of their general effectiveness but also for their relative safety to humans, animals, and plants.

For an excellent discussion on how pesticides are safety-tested, plus the story of how agricultural chemicals are used to protect our food, property, and health, read a book such as *Open Door to Plenty*, published by the National Agricultural Chemicals Association, 1145 19th St. N.W., Washington 6, D.C.

Laws governing the manufacture and distribution of pesticides require that the labels of dangerous chemicals contain:

- (1) the familiar skull and crossbones insignia,
- (2) the word "poison" in red letters,
- (3) a statement of antidote.

Such words as "Caution," "Warning," and "Danger" on a pesticide label indicate that the material is dangerous if misused.

Read and understand the entire package label before purchasing. The information is printed for your protection. Read the instructions again before using. Fungicides, like other pesticides, should be used according to package directions, on the crops specified, in the amounts specified, and at the times specified. Observe other precautions listed, especially safe handling and frequency of application.

Store chemicals in a locked, orderly-kept cabinet, outside the home, closed to irresponsible adults, children, and pets. Running water should be handy to flush away any spilled chemicals. Promptly destroy old pesticide containers.

Never use or store unlabeled chemicals, or those not in their original containers. Keep the pesticide container tightly closed except when preparing the mix.

Never breathe dusts, mists, or vapors of pesticides. Avoid spilling on shoes or other clothing. Immediately flush with water any body area contacted, and remove contaminated clothing and shoes.

Wear full protective clothing where called for, when applying pesticides. This may include rolled down trouser legs and sleeves, turned up collar and a washable cap. Do not eat or smoke while using pesticides.

Wash hands and face thoroughly before eating or smoking. Bathe promptly after spraying and change to fresh clothing. Launder clothing before reusing.

Cover bird baths, pet dishes, and fish pools while spraying or dusting.

Use wettable powder formulations or prepared dusts when combining insecticides and fungicides. Do not mix emulsion concentrates with wettable powders. Check the pesticide compatibility chart (page 446) in the Appendix before mixing chemicals together.

Do not apply any spray when the temperature is 85° F. or above.

Do not apply dormant oil sprays if the temperature is 40° F. or below or when the temperature is likely to drop below this figure during the next 24 hours.

Do not contaminate your sprayer with weedkillers, especially those of the hormone type such as 2,4-D, 2,4,5-T, or MCP. It's better to get a second sprayer and paint "WEED KILLERS ONLY!" in red on the sides.

Keep the sprayer or duster in good repair by following a regular maintenance program (pages 100, 104).

MEASURING APPARATUS

For help in measuring out small to large amounts of liquids or powders (or conversion from one to the other) see pages 420-22 in the Appendix.

To avoid guesswork and possible plant injury in mixing pesticides, the following equipment, where applicable, is suggested:

1. For measuring wettable powders or liquids get a set of standard household measuring spoons.
2. A letter balance is useful for weighing small amounts up to about 4 ounces.
3. A spring balance for weighing up to 4 pounds is something that many home gardeners will need. A larger scale weighing up to 25 pounds may be needed if large areas need spraying.
4. If using liquids, assemble a set of standard containers ($\frac{1}{4}$ pint, $\frac{1}{2}$ pint, 1 pint, 1 quart, 1 gallon, and 5 gallons).

Do not use this equipment in the kitchen or for other household purposes. Keep it locked up with your pesticides.

WHEN SPRAYING OR DUSTING

For good disease and insect control it is important that all parts of the plant be uniformly coated. When spraying, be sure to spray from the top of the plant

down, from the bottom up and the inside out. Remember that many fungi and bacteria penetrate only the underleaf surface. Apply a fine, misty spray which wets the foliage evenly. Keep the spray stream moving. Wet all surfaces until drops start to fall (run off).

One quart of spray mix should cover a 50-foot row of most flowers and vegetables when plants are young, and 20 to 25 feet when full grown.

Most sprays will be more effective if a wetting agent or spreader-sticker (see page 104) is added to the spray solution. Most household detergents and soaps are satisfactory. Add a sufficient amount (usually $\frac{1}{4}$ to 1 teaspoonful per gallon of spray) so that the spray solution will spread out on the leaf surfaces and not run off as large drops. Good coverage is essential and a spreader will help. A spreader-sticker is essential on glossy, hard-to-wet leaves.

The cone-type nozzle is generally preferred when spraying garden plants. The fan-type nozzle is principally used for applying insecticides on building surfaces and to protect outdoor living areas against mosquitoes and flies. The fan or flat spray nozzle is preferred for applying weed sprays.

If dusting, apply a thin dust film to all aboveground plant surfaces. Adjust the nozzles to insure puffing the dust up and through the plant. Apply dusts when plants are dry or nearly so and the air is calm. Early morning or evening is often best.

One ounce of dust usually covers a 50-foot row early in the season while 2 to 3 ounces are required later.

Always accurately measure the amounts of fungicide or insecticide spray materials you plan to use. The amounts which are recommended have been carefully calculated to provide the correct amount. That extra spoonful you may add is only

wasted—and may cause injury! Always measure, never guess.

The measures given throughout this book are in LEVEL spoonfuls and cupfuls.

For additional information on spraying fruits, see pages 423-26 in the Appendix.

MULTIPURPOSE SPRAYS AND DUSTS

Multipurpose (one-package) sprays or dusts control a wide range of pests. They are easy and generally safe to use and have encouraged more home gardeners to keep their plants as pest-free as possible. Multipurpose sprays and dusts have largely eliminated the necessity of stocking a large assortment of garden medicines. Many chemical companies and nurseries now have these mixes designed especially for use on tomatoes, potatoes, roses, flowers, gladiolus, vegetables, and fruits. Most mixes can be used on a wide variety of plants.

Found below are several safe and effective mixtures, now recommended by a number of states. But be sure to read the fine printing on the label before you buy. Methoxychlor, DDT, malathion, and rotenone are added to kill insects and mites.

Notes on Multipurpose Mixes

1. Where a fungicide (e.g., captan, zineb, maneb, or Karathane) is mentioned in the text, a multipurpose spray or dust containing the chemical may be substituted for the fungicide alone.

2. Captan is the preferred fungicide for use on fruits, and zineb or maneb on vegetables. Both are good for flowers, trees, shrubs, and lawns. Maneb is often substituted for zineb on tomatoes, potatoes, celery, and certain other plants.

3. Methoxychlor is preferred to DDT for use on food crops, especially within a month of harvest. DDT is generally more effective and longer-lasting.

VEGETABLES

zineb or maneb
methoxychlor
rotenone or malathion

FRUIT

captan
methoxychlor
malathion

FLOWERS, TREES, AND SHRUBS

zineb, captan, ferbam, or thiram
sulfur or Karathane
DDT or methoxychlor
malathion

4. Add Karathane, sulfur, Acti-dione, or phaltan to the vegetable and fruit mixes if powdery mildew becomes a problem.

"SHOT-GUN" SOIL DRENCH

A "shot-gun" treatment for treating flats, cold frames, hot beds, cutting benches, or flower beds for the control of organisms causing damping-off, cutting rot, crown and root rots, and stem cankers, consists of captan plus ferbam or thiram and Terraclor 75 (1 tablespoon of each per gallon of water). Apply as a soil drench using 1 pint to 1 quart per square foot. Some plants may be injured by this treatment. Check the label directions before using.

TO SPRAY OR TO DUST?

There really isn't *one* answer to the old question, "Should I spray or dust my plants?" The answer depends on what you want to accomplish, how many and how large are the plants you wish to protect, how tight your budget is, and how much time and interest you have in your garden plantings.

Many gardeners compromise and do both spraying and dusting. Spraying is done on a regular schedule. When extra applications are needed as a result of unexpected troubles or frequent rains, dusting will save time.

Sprays are generally preferred to dusts by commercial growers and experienced gardeners because they may be directed easily and specifically even on rather windy days. No worrying, either, about getting dust in your eyes or on plants that don't need it. Spray films are more effective and last longer than dusts, and materials cost less. Modern sprays do not leave an objectionable deposit on leaves, flowers, or fruit.

Dusts are often the choice of the average home gardener. Dusts are more quickly and easily applied than sprays; there is no messy mixing or measuring to worry about. Dusting can be a nuisance, though, if the air is not calm. Dusters cost less than comparable sprayers and are easier to carry and maintain. Dusting is generally impractical on large trees. Many gardeners prefer to dust flowers in

the spring and vegetables throughout the season. Spraying is considered preferable for flowers in or near bloom.

Strive for even, thorough coverage whether dusting or spraying.

Modern pesticides, including fungicides, may often be used either as sprays or dusts. For spraying, insecticides come as emulsions or wettable powders; fungicides are generally wettable powders. Aerosol "bombs" are available for treating a few indoor plants. Granular insecticides are widely used for controlling soil insects or for other special uses. There are even small mist blowers for home gardens. Spray-dusters and "fog" machines are somewhat in between spraying and dusting.

SPRAYERS AND DUSTERS

There is a type and size of sprayer or duster designed to fit everyone's needs—all the way from the person with only a few house plants to the large estate with acres of gardens or orchards which need protection.

Some devices are designed to serve a number of purposes; others are for specific jobs. The choice of a sprayer or duster for you depends on the size of the job, the type of application (spray or dust) desired, and the type of pesticide you use. Select the type of equipment that is within your budget and suits you best. Check these points when talking with your garden supply dealer: Does it handle and operate easily? Is it simple to fill and clean? Is it big enough for the job? Is the manufacturer reputable? Is it well-made with noncorroding parts? How long will it likely last if given good care? Remember, price should not be your main consideration.

Sprayers

Most sprayers now have a number of accessories and special fittings available to meet practically every situation. These include special nozzles, extension rods, extra hose, spray booms, pressure tanks, and special rubber-tired carts. Rust-free models—stainless steel, brass, or copper—will last longer than cheaper tinplate or galvanized models. For covering fruit and shade trees you'll need high pressures

(200 to 600 pounds or more per square inch). If the sprayer does not have an agitator, shake the solution as you spray.

Most gardeners prefer to have a separate sprayer, properly labeled, just for chemically controlling weeds. Many of the new weed killers, especially the hormone types, e.g., 2,4-D and 2,4,5-T, are extremely difficult to get completely out of sprayers. Check with your local county extension service on how to decontaminate sprayers in which 2,4-D or related materials have been used. USDA Farmers' Bulletin No. 2004, *Using 2,4-D Safely*, covers this subject in detail.

Clogging of spray nozzles can often be prevented by making up spray solutions in a thin, smooth batter of water and spray powder, then wash through fine-mesh cheesecloth or a silk stocking into the spray tank. Don't lay sprayer parts (e.g., plunger cylinder and nozzle) where they can pick up dirt or grass clippings, which might later clog the nozzle.

Household Sprayers (capacity 4 ounces to 1 gallon). Buy a type which shoots a continuous mist or fine spray and which has an adjustable nozzle. They are cheap, versatile, easy to operate, but limited to small jobs and the spray carries only a short distance. Coverage is difficult on underleaf surface. Frequent shaking is necessary to keep heavy suspensions from settling out.

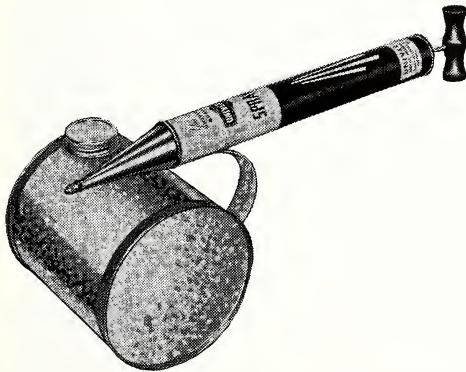


Fig. 54. Household sprayer. Continuous pressure type with a fully adjustable nozzle and three-quart capacity. (Courtesy Universal Metal Products Company)



Fig. 55A. A three-gallon, easy-rolling, compressed air sprayer simple to fill, empty, and pump. Note the special nozzle for spraying the lawn. (Courtesy Universal Metal Products Company)

Compressed Air Sprayers (1 to 5 gallons). Popular. Useful for a variety of jobs around the home, yard, and garden. Air is compressed into the tank above the spray liquid by a hand-operated air pump. Low-priced and easy to operate. Choose one with an open or funnel-type mouth, pressure-relief top, chemical-resistant hose, curved extension rod, and adjustable nozzle. Uncomfortable to carry over the shoulder, but some new models have a cart with rubber wheels. The normal operating pressure ranges from about 30 to 80 pounds and is maintained by occasional pumping. Use caution in opening the sprayer while there is still air pressure in the tank. Each sprayer is usually equipped with an assortment of nozzle discs to provide different spray patterns—solid cone, hollow cone, flat fan in fine or coarse spray, and solid stream.

Some models have carbon dioxide (CO_2) cylinders to provide operating pressure. These cylinders discharge up to 15 gallons of spray material at a uniform spraying pressure. They may be refilled at moderate cost.



Fig. 55B. A three-gallon compressed air sprayer with roto-spray, adjustable nozzle which is available in galvanized steel or stainless steel. (Courtesy H. D. Hudson Manufacturing Company)



Fig. 56. Knapsack sprayer with five-gallon capacity. Has dasher type agitator with a metal shield and comfort back. Its spray pressure goes up to 100 pounds. (Courtesy H. D. Hudson Manufacturing Company)

Knapsack Sprayers (2 to 6 gallons). Easy-pumping. Straps on back. Delivers a fine, continuous mist further than the compressed-air type but is more expensive. Buy type with agitation system to prevent suspension settling out. Heavy to carry for a lady. The pump handle on some models may be attached at either side permitting right-hand or left-hand pumping. Uniform spray pressures range from 80 to 180 pounds. Some models have a metal shield to prevent direct body contact with the cold tank surface.

Slide Pump or Trombone Sprayers. Relatively inexpensive, smooth, telescoping pumps which spray continuously. Spray carries a good distance (tops of medium-sized trees). Comes attached to a ½ gallon glass jar or a hose which dips into a bucket. Buy a type with specially treated, rust-resistant metal and an extension. Slide may become sticky in time. Tiring to use for a long time. Delivers pressures up to about 180 pounds.

Wheelbarrow, Cart, and Barrel Sprayers (7 to 50 gallons). Similar but generally have larger and more powerful pumps than the slide pump. Made in a variety of designs mounted on various types of frames (e.g., wheelbarrow, horizontal or vertical cart, bucket or barrel). Cart or wheelbarrow models have 2, 3, or 4 wheels for easy transport. A moving, large, full sprayer is difficult to maneuver on soft, wet, or unlevel soil. Continuous high pressures, up to about 250 pounds, may be developed for spraying medium-sized trees. Spraying is easier with two people: one spraying and the other manning the pump handle.

Some cart sprayers have a special pressure tank which is precharged with a tire pump or at a filling station. One "charge" gives about 10 minutes of continuous spraying at a constant, desired pressure of up to 200 pounds.

Garden Hose Sprayers are screwed on the end of your garden hose and water supplies the pressure. Add concentrated pesticides to a glass or polyethylene jar attached to the garden hose. The spray gun attached to the lid meters out the spray concentrate from the jar by suction and mixes it with water from the hose flowing through the gun. A quart jar of concentrate spray will make a number of gallons of dilute spray. Most models use liquids or wettable powders. Materials may not be applied at a constant rate. Hose pressure may not be sufficient to break spray into a fine mist. Adding detergent to the spray will help. Use is limited to the garden area that can be reached with the hose.



Fig. 57A. A slide type brass sprayer attached to a glass jar. Shoots any spray from a fine mist to 25-foot stream. The nozzle rotates 360 degrees for easy spraying. (Courtesy Root-Lowell Corporation)



Fig. 57B. A brass trombone spray with "gun" grip which shoots a fine mist to a 25- to 30-foot spray stream, up to 180 pounds pressure. It comes with 6 feet of $\frac{3}{8}$ inch red plastic hose. The type shown here has a built-in 15-inch extension that telescopes in or out of the sprayer. It sprays with continuous pressure. (Courtesy H. D. Hudson Manufacturing Company)

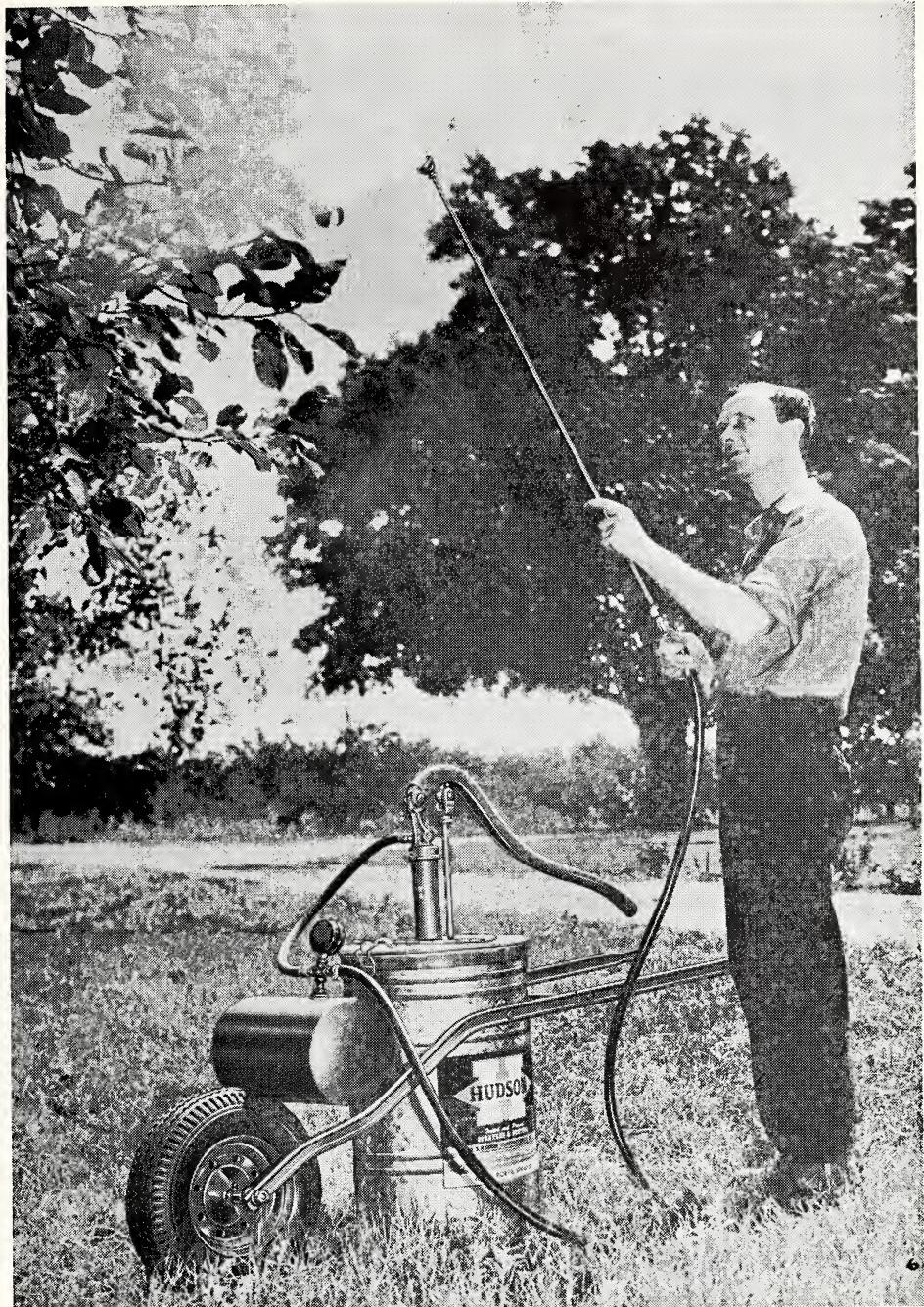


Fig. 58. Wheelbarrow sprayer (17½ gallons). This powerful, high pressure pump delivers up to 250 pounds pressure. Note the pressure tank (optional), pressure gauge, and tank cover to prevent spillage. (Courtesy H. D. Hudson Manufacturing Company)

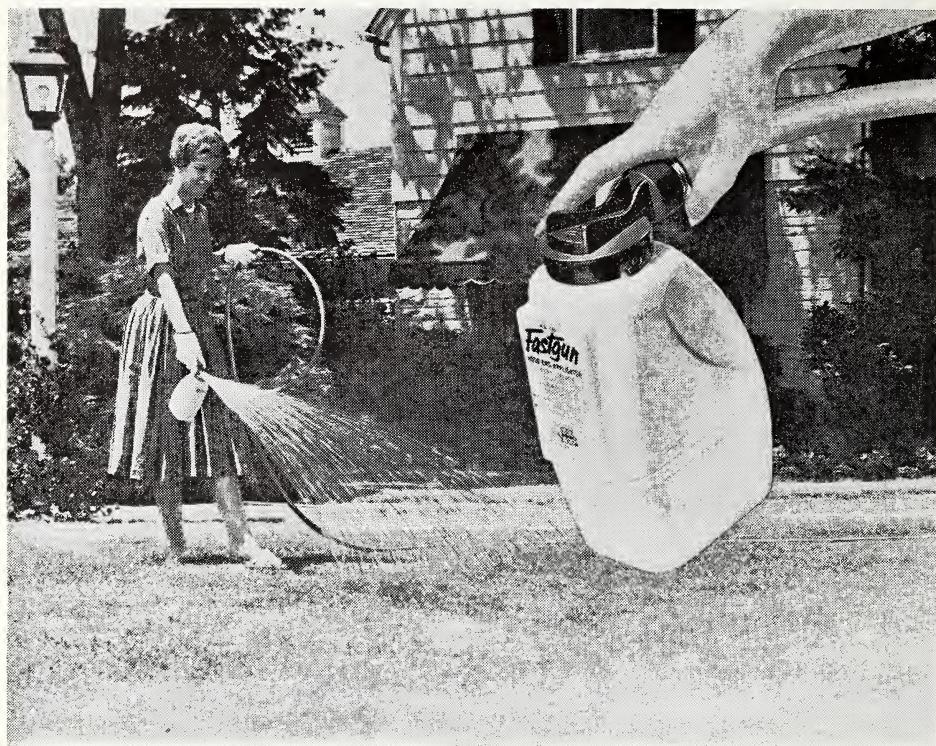


Fig. 59. Garden hose-end sprayer of ten gallon capacity which is made of shatter-proof polyethylene plastic and is lightweight, quick, low cost, and handy. Get one like this with finger-tip siphon control and capacity markings for accurate proportioning. (Courtesy H. D. Hudson Manufacturing Company)



Fig. 60A. Horizontal, 10-gallon sprayer which is mobile, easily filled and cleaned, and produces high, constant pressure. It comes with 15 feet of hose and spraying gun. (Courtesy of Oakes Manufacturing Company, Inc.)

Small Power Sprayers (7 to 50 gallons). Wheelbarrow or estate types are available which vary greatly in design and special features. A gasoline engine with a powerful 1- or 2-cylinder pump generally delivers from 1 to 5 gallons of spray per minute at a pressure of 20 to 400 pounds. Pressure is regulated accurately. Get a large-wheeled, easily maneuverable model with extra hose, agitator, and adjustable, trigger-control spray gun. This sprayer is excellent for small orchards, large gardens, and estates, but is relatively expensive. It is not economical of spray material. Some types may have such features as a trailer or tractor hitch for hauling, a spray boom for row-crop spraying, and skid mount.



Fig. 60B. Erect, 12½-gallon sprayer with large, easy-rolling wheels, adjustable pressure regulator, and constant, mechanical agitator. (Courtesy H. D. Hudson Manufacturing Company)

MAINTENANCE OF SPRAYERS

Carefully follow the manufacturer's recommendations and instructions for lubrication, operation, and maintenance which accompany the sprayer. Before starting a new power sprayer, check all designated points for proper lubrication. Operate the sprayer at slow speed using water while checking the delivery system, operation of control valves, and the pressure regulator.

All types of sprayers should be thoroughly rinsed when changing to a different type of spray solution. Clean immediately after each use by pumping at least two changes of clean water through the system. Store funnel-top sprayers in an upside down position with the hand pump removed.

Several times during the season, clean hand sprayers more thoroughly by filling the spray tank with hot water and let stand for a few minutes. Where possible, take apart and clean the pump, extension tubes, nozzle parts, and shut-off valve. Wash strainers and nozzle parts with kerosene. Use an old toothbrush or a jet of compressed air. Replace washers that have become worn and nozzle discs that have enlarged holes. Reassemble and pump water through the open nozzle head to flush out the discharge line. Finally, pump to full pressure and check hose and gasket for leaks. Be sure the shut-off valve is working properly. If the pump fails to develop full pressure, remove the plunger to the cylinder and reshape the leather so that it seals tightly.

Household sprayers require little care or maintenance. If the pump should lose its compression, pull the pump handle all the way out and add a few drops of oil in the air hole at the end of the pump cylinder. This lubricates the plunger cup or leather.

Leave *hand sprayers* partially unassembled for the winter. Metal parts should be lightly oiled and wrapped in newspaper. The tank should be clean and dry.

For *power sprayers*, follow the manufacturer's directions regarding proper lubrication and any special care required. Clean the sprayer after each use. Drain and flush the tank with clean water. Take apart the nozzles and strainers and wash

them with kerosene. Before reassembling, pump water through the discharge system until it comes out clean.

After spraying is completed in the fall, soak nozzles and strainers (screens) in kerosene. Run wire through the spray rods. Rinse hoses clean and put where they will not crack or freeze.

After cleaning, and before putting a power sprayer away for the winter, pour at least a pint of new or used oil in the tank. Fill with water and start the pump. As the water is discharged, a thin coating of oil covers the inside of the tank, pump, valves, and circulating system. Finally drain the sprayer completely and store in a dry place.

Dusters

Of simpler construction than comparable sprayers with fewer parts to go wrong. For maximum protection and safety, dust only when the air is calm (this may mean early morning or evening). Don't dust if plants are wet—you'll get unsightly deposits!

Plunger Type Dusters (capacity $\frac{1}{2}$ to $1\frac{1}{2}$ pounds of dust). Easy to operate and handy for treating small areas with little waste. Choose one with a dust chamber made of metal or glass. Larger models with an extension tube and adjustable nozzle or deflector cap are much handier to use. Avoid the "salt shaker," flick, plastic squeeze, and telescoping cardboard carton types. They may be convenient for small jobs but generally do not provide uniform coverage.

Small Bellows, Crank, or Rotary-Fan Dusters ($\frac{1}{2}$ to 5 pounds). Easy to use and gives better coverage than the plunger type. Ideal for continuous dusting of small or large gardens. It is cheap, lightweight, faster than spraying. It may be difficult to direct dust exactly where you want it. Small models require frequent refilling. Get the type with an adjustable feed control. The duster may be carried in front by shoulder straps.

Knapsack Dusters (5 to 25 pounds). Suitable for large gardens and estates. Throws up a steady, fine cloud of dust. Covers large areas rapidly without refilling. Lightweight, simple to use. General types: *Bellows type* (strapped on back) and the



Fig. 61. Plunger type duster which holds about 1 pound of dust. The long 21-inch extension with all-angle swivel deflector makes dusting simple. It discharges a uniform cloud. (Courtesy of H. D. Hudson Manufacturing Company)



Fig. 62A. This easy turning crank duster holds about $\frac{3}{4}$ pound of dust, light and compact, emits a fine, uniform cloud of dust. Nozzle is adjustable to any angle.
(Courtesy H. D. Hudson Manufacturing Company)



Fig. 62B. This easy turning crank duster holds about 14 pounds of dust yet is easy to carry. The agitator assures even flow. It has a fan-shaped, adjustable nozzle which can dust to front or rear. (Courtesy H. D. Hudson Manufacturing Company)



Fig. 63. Knapsack duster. Holds about 17 pounds of dust. It has a built-in filler scoop in cover. It is easily carried on the back and is ideal for spot dusting or complete coverage. (Courtesy H. D. Hudson Manufacturing Company)

Rotary-fan type (carried in front by shoulder straps and operated with a hand crank). Delivery tubes and nozzles are adjustable for both height and direction. Buy the type with a long extension tube and flaring "fish-tail" nozzles. They are more expensive than hand dusters, but may be used for either intermittent or continuous dust applications.

Small Power Dusters (60 to over 200 pounds). Practical for large gardens, small orchards, or estates. Small models (weighing 40 to 67 pounds) are carried on the back; larger ones are powered by an engine or tractor. The metering device (or feed regulator) may be adjusted to apply from 5 to 50 or 100 pounds of dust per acre. Covers large areas rapidly without refilling. Wasteful of material, as dust often blows onto other plants. Buy the type with an agitator. Power dusters vary greatly in the size of the dust hopper, type and capacity of the fan, type of distribution system, horsepower, and mounting.

MAINTENANCE OF DUSTERS

Follow the manufacturer's directions regarding operating instructions and lubrication of moving parts. Use graphite for lubricating the steel rod and plunger in hand plunger dusters. Oil stains the equipment.

Empty and clean the duster after using to prevent caking, clogging, and eventual corrosion. All slip joints should be given a protective coating in the fall before storing over winter in a dry place. The fan on power dusters should be operated at recommended speeds.

For an excellent discussion of sprayers, dusters, their operation and uses, obtain a copy of *Sprayer and Duster Manual*, published by the National Sprayer and Duster Association, Room 1500, 300 South Wells St., Chicago 6, Illinois.

SPREADERS, STICKERS, AND WETTING AGENTS

The purpose of these materials is to help suspend the pesticide in the spray solution, improve the cohesiveness of the spray or increase the wetting of leaves by the spray, or all three. All commercial pesticides now have one or more of these materials already in the spray mix.

The adding of a commercial or home-

made spreader-sticker or wetting agent is recommended before spraying glossy, hard-to-wet foliage like roses, gladiolus, carnation, iris, tulip, onion, cabbage, pea, rhododendron, and mountain-laural. These materials also aid in controlling powdery mildews and insects with a waxy coating like woolly aphids and mealybugs.

Commercial *spreaders* (wetting agents) that ensure wetting of hairy or glossy foliage include Santomerse, Tween-20, Fluxit, and household soaps or detergents (e.g., Dreft, Tide, Vel, and Liquid Lux). Spreaders are used at the rate of $\frac{1}{4}$ to 1 teaspoon per gallon.

Common *stickers* that allow pesticides to adhere tenaciously to plant surfaces include powdered skim milk, wheat or soya flour, fish oil, or casein. Use 1 tablespoon of wheat flour per gallon. Goodrite P.E.P.S. is a good commercial sticker.

Commercial *spreader-stickers* are available under many trade names — among them Du Pont Spreader-Sticker, Filmfast, Nu-Film, Ortho Spreader-Sticker, Orthex Spreader-Adhesive, Triton B-1956, Sterox, and Plyac Spreader-Sticker. Most of the commercial spreader-stickers are used at the rate of $\frac{1}{4}$ to $\frac{1}{2}$ teaspoon per gallon.

PARTIAL LIST OF FUNGICIDE MANUFACTURERS AND DISTRIBUTORS PLUS LEADING SPRAYING AND DUSTING EQUIPMENT MANUFACTURERS

Acme Quality Paints, Inc., 8250 St. Aubin Ave., Detroit 11, Mich.

Allied Chemical Corp., General Chemical Div., 40 Rector St., New York 6, N.Y.
American Cyanamid Co., Agric. Chemicals Div., P.O. Box 672, Princeton, N.J.
Antrol Garden Products, Boyle-Midway, 22 East 40th St., New York 16, N.Y.
Barco Mfg. Co., Inc., 119 Dewey St., Worcester, Mass.

Bradson Company, 2165 Kurtz St., San Diego, Calif.

California Spray-Chemical Corp., Lucas and Ortho Way, Richmond, Calif.
Champion Sprayer Co., 6509 Heintz Ave., Detroit 11, Mich.

Chemley Products Co., 5744 N. Western Ave., Chicago 45, Ill.

Chipman Chemical Co., Inc., P.O. Box 309, Bound Brook, N.J.

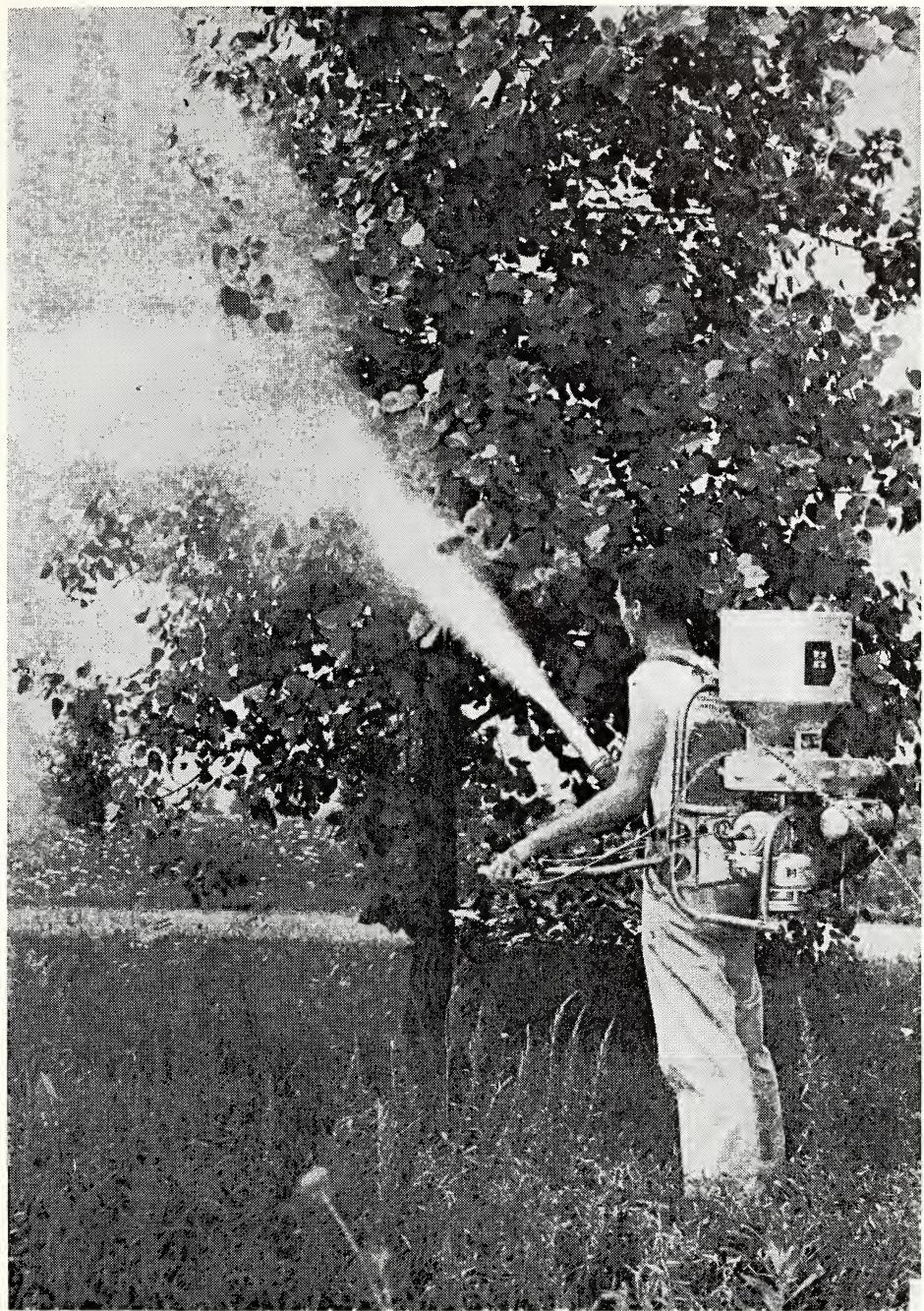


Fig. 64. Power duster. Holds about 25 pounds of dust, yet is easily carried on a man's back. It dusts up to 25 feet high and can also be used for mist spraying. (Courtesy H. D. Hudson Manufacturing Company)

- W. A. Cleary Corp., Box 749, New Brunswick, N.J.
- Doggett-Pfeil Co., Springfield, N.J.
- The Dow Chemical Co., Midland, Mich.
- Eastern States Farmers' Exchange, Inc., 26 Central St., West Springfield, Mass.
- E. I. du Pont de Nemours & Co., Grasselli Chem. Dept. or Industrial and Biochemicals Dept., Wilmington 98, Del.
- Faesy & Besthoff, Inc., 25 E. 26th St., New York 10, N.Y.
- Hayes Spray Gun Co., 98 No. San Gabriel Blvd., Pasadena, Calif.
- H. D. Hudson Mfg. Co., 1589 East Illinois St., Chicago 11, Ill.
- Imperial Chemical Co., Shenandoah, Iowa.
- Mallinckrodt Chemical Works, 2nd and Mallinckrodt Sts., St. Louis 7, Mo.
- Miller Chemical & Fertilizer Corp., 2226 N. Howard St., Baltimore 18, Md.
- Miller Chemical Co., 525 N. 15th St., Omaha 2, Nebr.
- Morton Chemical Co., Agricultural Chemical Division, 110 N. Wacker Dr., Chicago 6, Ill.
- Niagara Chemical Div., Food Machinery & Chemical Corp., 100 Niagara St., Middleport, N.Y.
- The Oakes Mfg. Co., Inc., 516 Dearborn St., Tipton, Ind.
- Olin Mathieson Chemical Corp., Mathieson Bldg., Baltimore 3, Md.
- Charles Pfizer & Co., Inc., 630 Flushing Ave., Brooklyn 6, N.Y.
- Pittsburgh Plate Glass Co., Corona Chemical Div., Moorestown, N.J.
- Rohm & Haas Co., 222 W. Washington Square, Philadelphia 5, Pa.
- Root-Lowell Corp., 445 N. Lake Shore Drive, Chicago 11, Ill.
- Shell Chemical Corp., Agr. Chemicals Sales Div., 460 Park Ave., New York 22, N.Y.
- Sherwin-Williams Co., 1113 Guild Hall Bldg., 101 Prospect Ave. N. W., Cleveland 1, Ohio.
- D. B. Smith & Co., 483 Main St., Utica 2, N.Y.
- Stauffer Chemical Co., 380 Madison Ave., New York 17, N.Y.
- Tennessee Corp., 619 Grant Bldg., Atlanta 1, Ga.
- Thompson-Hayward Chemical Co., 2915 Southwest Blvd., Kansas City 8, Mo.
- The Upjohn Co., 301 Henrietta, Kalamazoo, Mich.
- Union Carbide Chemicals Co., Div. Union Carbide Corp., 180 S. Broadway, White Plains, N.Y.
- Universal Metal Products Co., Saranac, Mich.
- U.S. Rubber Co., Naugatuck Chemical Div., Naugatuck, Conn.
- Vaughan Seed Co., 601 W. Jackson Blvd., Chicago, Ill.
- Westbrook Mfg. Co., St. Joseph, Mich.

SECTION 4

Home and Garden Plants and Their Diseases

African-violet	109	Gladiolus	232
Anemone	112	Grape	237
Apple	114	Heath	243
Ash	124	Holly	245
Avocado	127	Hollyhock	246
Barberry	129	Honeylocust	248
Bean	131	Horsechestnut	250
Beet	136	Hydrangea	252
Begonia	139	Iris	254
Bellflower	140	Ivy	257
Birch	142	Juniper	259
Bittersweet	143	Lantana	263
Blueberry	145	Larch	264
Boxwood	150	Lawngrass	265
Cabbage	154	Lettuce	272
Cactus	161	Lily	277
Calla	162	Magnolia	283
Camellia	164	Maple	284
Canna	167	Mertensia	288
Carnation	169	Morning-glory	290
Carrot	171	Oak	295
Celery	175	Oleander	298
Chrysanthemum	181	Onion	299
Citrus	187	Orchids	302
Cockscomb	189	Pansy	309
Corn	190	Pea	311
Cucumber	196	Peach	315
Currant	201	Phlox	327
Cyclamen	203	Pine	330
Daffodil	204	Poplar	337
Delphinium	208	Poppy	338
Dogwood	211	Potato	339
Elm	217	Primrose	344
Ferns	223	Raspberry	347
Fig	224	Rhododendron	351
Forsythia	226	Rose	356
Fuchsia	228	St.-Johns-wort	362
Gardenia	228	Salvia	362
Gentian	230	Sedum	366
Geranium	231	Snapdragon	368

Snowberry	371	Tulip	399
Spirea	374	Valerian	403
Strawberry	375	Viburnum	404
Sumac	380	Vinca	405
Sweetpotato	382	Walnut	406
Sycamore	385	Willow	411
Tomato	389	Yew	414

Garden plants are listed below, together with their more important diseases. The prevalent or serious diseases are listed first. For local or minor diseases, check with your extension plant pathologist or county agent. For additional information on the different general diseases or control measures, see sections 2 and 3 plus the Appendix.

AARONSBEARD — See St.-Johns-wort

AARONS-ROD — See Pea

ABELIA — See Snowberry

ABIES — See Pine

ABRONIA — See Four-o'clock

ABRUS — See Pea

ABUTILON — See Hollyhock

ACACIA — See Honeylocust

ACALYPHA, COPPERLEAF [PAINTED, VIRGINIA] (*Acalypha*)

1. *Leaf Spots* — Leaves variously spotted. May wither, die, and drop prematurely. *Control:* Usually unnecessary. Pick off and burn infected leaves. Space plants. Increase air circulation.
2. *Red Leaf Gall* — Reddish galls develop on leaves. *Control:* Same as for Leaf Spots.
3. *Downy Mildew* — See under Calla, and (6) Downy Mildew under General Diseases.
4. *Powdery Mildew* — See (7) Powdery Mildew under General Diseases.
5. *Oedema* — Indoor problem. Small, rust-colored spots or overgrowths on leaves. *Control:* Avoid overwatering and high humidity. Increase air circulation.
6. *Root Rots* — See under Geranium, and (34) Root Rot under General Diseases. May be associated with nematodes (e.g., root-lesion or meadow, root-knot).
7. *Root-knot* — See (37) Root-knot under General Diseases.

ACANTHOPanax, FIVE-LEAF or FIVE-FINGERED ARAlia, CASTOR ARAlia

**(*Acanthopanax*, *Kalopanax*); AMERICAN SPIKENARD, HERCULES-CLUB,
SARSAPARILLA, UDO (*Aralia*)**

1. *Leaf Spots or Blight, Spot Anthracnose, Scab* — Spots of various colors, sizes, and shapes on leaves. See (1) Fungus Leaf Spot under General Diseases.
2. *Root Rots, Stem Rot, Watery Soft Rot* — See (21) Crown Rot, and (34) Root Rot under General Diseases.
3. *Verticillium Wilt* (udo, American spikenard) — See (15B) Verticillium Wilt under General Diseases.

4. *Rust* (American spikenard, sarsaparilla) — Dark, powdery pustules on the leaves. *Control:* Pick off and burn infected leaves.
5. *Powdery Mildew* (sarsaparilla) — Powdery, white mold growth on the foliage. See (7) Powdery Mildew under General Diseases.
6. *Twig and Branch Cankers, Dieback* (Hercules-club) — Twigs and branches die back from discolored, girdling cankers. *Control:* Pick off and burn affected parts. Make cuts several inches below any sign of infection.
7. *Wood Rot* (Hercules-club) — See under Birch, and (23) Wood Rot under General Diseases.

ACHILLEA — See **Chrysanthemum**

ACHLYS — See **Barberry**

ACIDANTHERA — See **Gladiolus**

ACONITE, ACONITUM — See **Delphinium**

ACTAEA — See **Anemone**

ACTINOMERIS — See **Chrysanthemum**

ADAM-AND-EVE — See **Erythronium**

ADAMS-NEEDLE — See **Yucca**

ADDERSTONGUE — See **Erythronium**

ADIANTUM — See **Ferns**

AESCRULUS — See **Horsechestnut**

AETHIONEMA — See **Cabbage**

AFRICAN DAISY — See **Chrysanthemum**

AFRICAN FORGET-ME-NOT — See **Mertensia**

AFRICAN-LILY — See **Tulip**

AFRICAN-VIOLET (*Saintpaulia*); **FLAME VIOLETS** (*Episcia*);
STARFIRE (*Gesneria*); **GLOXINIA** (*Sinningia*)

1. *Crown Rots, Stem Rot, Root Rots* — Widespread. Soft, mushy, brown rot of crown and petioles. Plants sickly. Gradually or suddenly wilt, wither, and die. Plants are easily pulled up. See Figure 37B under General Diseases. Often associated with nematodes (e.g., lance, pin, root-knot, root-lesion or meadow, spiral, stubby-root, stylet or stunt). *Control:* Plant healthy stock in sterilized soil in sterilized containers (see pages 437-44). Take cuttings only from healthy plants. Root in a sterile medium. Avoid overwatering, overfertilizing, and deep planting. Destroy badly infected plants. Keep water off the foliage. Increase air circulation. Soil should be well-drained. Drenching the soil with ferbam (2½ tablespoons per gallon) may be beneficial.
2. *Botrytis Blight, Gray-mold Blight, Leaf Rot, Bud Rot* — Cosmopolitan. Soft, tan rot of crown, buds, flowers, or leaves. A coarse, gray mold may grow on diseased tissue. *Control:* Keep down the humidity and increase the air circulation. Avoid overwatering and overcrowding. Destroy fading blooms promptly. Spray with zineb during humid weather. Control mites with malathion dips or sprays.

3. *Ringspot* — General. Whitish to bright yellow rings, arcs, and streaks on the upper leaf surface. *Control:* Keep cold water off the foliage. Avoid sudden temperature changes. Keep plants out of direct sunlight for an hour before watering.
4. *Root-knot* — General. Plants sickly, make poor growth. Small, irregular, knotlike galls on the roots, crowns, stems, and even the leaves. Leaves are often thickened and blistered. *Control:* Plant only disease-free cuttings in sterilized soil in sterilized containers. Remove and burn badly infested plants.
5. *Leaf Scorch, Chlorosis* — Leaves pale to yellow and may appear as if scorched by fire. *Control:* Keep plants out of bright sun, and away from the heating effects of large incandescent light bulbs.
6. *Powdery Mildew* — Whitish-gray mold patches on the leaves and flowers. Flowers

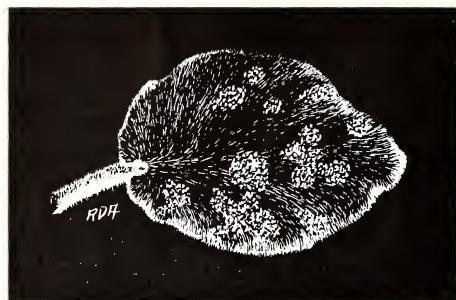


Fig. 65. Powdery mildew of
African-violet

may be deformed and discolored. See Figure 65. *Control:* Destroy old infected leaves and flowers. Space plants farther apart. Remove old leaves close to the soil. Dip or spray with Karathane ($\frac{1}{2}$ teaspoon per gallon) plus a spreader-sticker. Two applications, 10 days apart, should be sufficient. Otherwise same as for Botrytis Blight (above).

7. *Mosaic* — Leaves crinkled and thickened. May show irregular light and dark green blotches. Plants may be stunted. Flowers are reduced in size and number. *Control:* Destroy infected plants.
8. *Bud Drop* — Flower buds shrivel, turn brown, and drop before opening. *Control:* Avoid low temperatures and air humidity, overwatering, gas injury, and extremes in soil temperature, moisture, and light. Control mites and other bud pests. Check with your local florist or extension entomologist.
9. *Leaf or Foliar Nematode* — Gradually enlarging, sunken, brown blotches between the leaf veins. Spots appear mostly on the underleaf surface. Plants stunted, sickly, may die. *Control:* Same as for Root-knot (above). Remove and burn infested leaves. Soak potted plants in hot water (110° F.) for 30 minutes. Keep water off the foliage.
10. *Spotted Wilt (gloxinia)* — Large, brown-ringed patterns with green centers on the leaves. Leaves may die. *Control:* Destroy infected plants. Spray with DDT or malathion to control thrips which transmit the virus.
11. *Aster Yellows (gloxinia)* — Plants slightly yellowish. Produce numerous secondary shoots and no flowers. *Control:* Same as for Spotted Wilt. Use DDT or malathion to control leafhoppers which transmit the virus.
12. *Sclerotinia Blight of Gloxinia* — California. Soft, rapid rot of the flowers which causes them to collapse. When infected flowers drop on the leaves, the rot moves into the leaves and then down the petioles. The growing point may be killed,

stunting the plant. *Control:* Pick off and burn rotting flowers when first found. Apply Terraclor to the soil following the manufacturer's directions. Same as for Crown Rot (above).

13. *Petiole Rot* — Leaves wilt and wither from a rotting of the petioles where they touch the salt-encrusted pot. *Control:* Cover pots with aluminum foil or other material.

AGAPANTHUS — See **Tulip**

AGAVE — See **Centuryplant**

AGERATUM — See **Chrysanthemum**

AGLAONEMA — See **Calla**

AGROPYRON — See **Lawngrass**

AGROSTEMMA — See **Carnation**

AILANTHUS — See **Tree-of-Heaven**

AIR POTATO — See **Yam**

AJUGA, BUGLEWEED (Ajuga)

1. *Crown Rot, Southern Blight* — Serious in shady, wet, poorly drained areas. Plants suddenly wilt and die in warm, humid weather. Bases of stems in patches rot and turn black. Frequently covered with a cottony mold growth. *Control:* See under Delphinium. Apply Terraclor (PCNB) to the soil surface a week before planting. Follow the manufacturer's directions.
2. *Root-knot* — Plants may be sickly and stunted with knotlike galls on the roots. See (37) Root-knot under General Diseases.

ALBIZZIA — See **Honeylocust**

ALDER — See **Birch**

ALKANET — See **Mertensia**

ALLIONIA — See **Four-o'clock**

ALLIUM — See **Onion**

ALLSPICE — See **Calycanthus**

ALMOND — See **Peach**

ALOE, HAWORTHIA

1. *Root Rot* — Serious nursery disease. See under Geranium. *Control:* Plant in light, well-drained soil. Avoid overwatering. Clean infected aloe plants and soak them in hot water (115° F.) for 20 to 40 minutes. Plant treated plants in clean or sterilized soil (pages 437-44).

ALPINE Currant — See **Currant**

ALTERNANTHERA — See **Cockscomb**

ALTHAEA — See **Hollyhock**

ALUMROOT — See **Delphinium**

ALYSSUM — See Cabbage

AMARANTH, AMARANTHUS — See Cockscomb

AMARYLLIS, AMAZON-LILY — See Daffodil

AMELANCHIER — See Apple

AMERICAN BLADDERNUT (*Staphylea*)

1. *Leaf Spots* — Spots of various sizes, shapes, and colors on leaves. *Control:* Collect and burn fallen leaves. Keep plants well pruned. If practical, spray during spring and summer rainy periods using zineb, maneb, or captan.
2. *Twig Blights* — Twigs blighted. May die back. *Control:* Prune out and burn affected parts. Otherwise same as for Leaf Spots.
3. *Sooty Blotch* — See (12) Sooty Mold under General Diseases.

AMERICAN COWSLIP — See Primrose

AMERICAN LINDEN — See Linden

AMERICAN SPIKENARD — See Acanthopanax

AMORPHA — See False-indigo

AMPELOPSIS — See Grape

AMSONIA — See Vinca

ANAGALLIS — See Primrose

ANAPHALIS — See Chrysanthemum

ANCHUSA — See Mertensia

ANDROMEDA [FORMOSA, JAPANESE, MOUNTAIN] (*Pieris*)

1. *Leaf Spots, Tar Spot* — Small spots on leaves in which black dots may later be sprinkled. *Control:* Apply zineb, maneb, or ferbam sprays at 2-week intervals, starting when leaves are half grown.
2. *Root Rot, Dieback* — Roots decay. Plants gradually decline, wither, die back, and finally die. Often associated with nematodes (e.g., bloat, lance, pin, reniform, ring, root-lesion, spiral, stubby-root, stunt or stylet). *Control:* See under Apple, and (34) Root Rot under General Diseases.

ANDROSACE — See Primrose

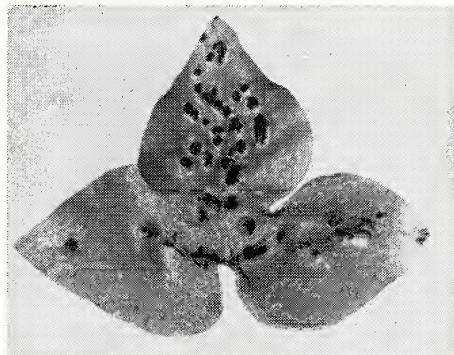
ANEMONE [JAPANESE, POPPY, AND WOOD], PASQUEFLOWER, WINDFLOWER (*Anemone*); BANEERRY [RED, WHITE] (*Actaea*); RUE-ANEMONE (*Anemonella*); BUGBANE, BLACK-SNAKEROOT or BLACK COHOSH (*Cimicifuga*); LIVERLEAF (*Hepatica*); GLOBEFLOWER (*Trollius*)

1. *Leaf Spots* — Spots of various sizes, shapes, and colors on leaves. Leaves may discolor and drop early, usually starting at the base of the plant. *Control:* Space plants. If serious, apply maneb, zineb, fixed copper, ferbam, or captan at about 10-day intervals during wet weather. Destroy infected plant parts as soon as found. Burn tops in the fall.
2. *Rusts* — Powdery, brown pustules or "orange cluster cups" on the lower leaf surface.

Affected plants do not flower. Leaves may be stunted, thickened, crowded, turn pale and fleshy. Alternate hosts include plums, cherries, and various grasses. *Control:* Dig out and burn infected *anemone* plants as they will not recover. Spray or dust as for Leaf Spots (above). Propagate from disease-free plants.

3. *Downy Mildew* — Widespread on anemone. Large brown or black blotches on leaves. Corresponding undersides of leaves are covered with delicate, white mildew patches. Leaves tend to roll upwards. Plants distorted. *Control:* Same as for Leaf Spots (above).
4. *Leaf and Stem Smuts* — Irregular, dark brown to black, powdery blisters and streaks on swollen regions of leaves and leaf stalks. Common on wood anemone. See Figure 66. *Control:* Same as for Rusts (above).

Fig. 66. Anemone smut.



5. *Leaf Gall, Spot Disease* (*anemone*) — Flowers, stems, and leaves spotted with small red warts. Flowers may become dwarfed, distorted, and fall early. *Control:* Same as for Leaf Spots (above).
6. *Leaf and Stem Nematode* — Dark brown or black blotches on leaves. Leaves may die. *Control:* See (20) Leaf and Stem Nematode under General Diseases.
7. *Powdery Mildew* (*anemone*, *rue-anemone*) — See (7) Powdery Mildew under General Diseases.
8. *Crown Rot, Rhizome Rot, Southern Blight* (*anemone*) — Underground parts or stem rots at the soil line. Plants wilt, wither, and collapse. *Control:* Completely dig out and destroy infected plants together with 6 inches of surrounding soil. Sterilize remaining soil with heat or chemicals. See "Soil Treatment Methods and Materials" in the Appendix.
9. *Botrytis Collar Rot* (*anemone*) — Crowns rotted and destroyed near the soil line. Flowers and flower buds may rot. *Control:* Avoid crowding plants. Plant in light, well-drained soil. Spray as for Leaf Spots (above).
10. *Mosaic, Flower Breaking* (*anemone*) — Leaves mottled light and dark green. May show some yellowing. Flowers may show light or off-color streaks and blotches. *Control:* Destroy infected plants. Keep down weeds. Control the aphids which transmit the virus, using lindane or malathion.
11. *Aster Yellows* — See (18) Yellows under General Diseases.
12. *Spotted Wilt* (*anemone*) — See (17) Spotted Wilt under General Diseases. *Control:* Same as for Mosaic (above). Spray with DDT and malathion to control thrips, which transmit the virus.
13. *Root-knot* — See (37) Root-knot under General Diseases.

ANEMONELLA — See Anemone**ANETHUM — See Celery****ANGELICA; TAENIDIA**

1. *Leaf Spots* — General. Spots of various sizes, shapes, and colors on the leaves. If severe, leaves may wither. *Control*: Collect and burn tops in the fall. Space plants. If severe, apply zineb, maneb, or ferbam at about 10-day intervals during rainy weather.
2. *Rusts* — Yellow, orange, reddish-brown or black, powdery pustules on leaves. *Control*: Same as for Leaf Spots (above).
3. *Root Rot* — See (34) Root Rot under General Diseases.

ANGELS-TRUMPET — See Tomato**ANGRAECUM — See Orchids****ANISE, ANISE-ROOT — See Celery****ANISETREE — See Magnolia****ANNUAL BLANKET-FLOWER — See Chrysanthemum****ANODA — See Hollyhock****ANTENNARIA, ANTHEMIS — See Chrysanthemum****ANTHONY WATERER — See Spirea****ANTHRISCUS — See Celery****ANTHURIUM — See Calla****ANTIRRHINUM — See Snapdragon****APIUM — See Celery**

APPLE, CRABAPPLE [ARNOLD, BECHTEL'S, CARMINE, CHARLOTTE'S, CHINESE FLOWERING, CUTLEAF, ELEY'S, GARLAND or WILD SWEET, HALLIS, HYBRID, JAPANESE FLOWERING, KAIKO, MANDSHURIAN, PARKMAN'S, PRAIRIE, PURPLE, RIVERS', SARGENT, SCHEIDECKERI, SIBERIAN, SOULARD, SOUTHERN, TEA, TORINGO] (*Malus*); **SERVICEBERRY** [ALLEGHANY, APPLE, CLUSTER, CUSICK, DOWNTY, WESTERN], JAPANESE JUNEBERRY, JUNEBERRY, SHADBLOW, SHADBUSH (*Amelanchier*); **CHOKEBERRY** [BLACK, PURPLE, RED] (*Aronia*); **FLOWERING QUINCE** [DWARF JAPANESE, JAPANESE, CHINESE QUINCE] (*Chaenomeles*); **HAWTHORN or THORN** [ARNOLD, COCKSPUR, DOTTED, ENGLISH, FLESHY, LAVALLE'S, PAUL'S DOUBLE SCARLET, RED HAW or SCARLET, WASHINGTON] (*Crataegus*); **COTONEASTER** [BEARBERRY, BOXLEAF, COIN-LEAF, CRANBERRY, CREEPING, HUPEH, MANYFLOWER, NECKLACE, PEKING, ROCK or QUINCEBERRY, ROCKSPRAY, SMALL-LEAF, SPREADING] (*Cotoneaster*); **QUINCE** (*Cydonia*); **LOQUAT** (*Eriobotrya*); **MEDLAR** (*Mespilis*); **CHINESE PHOTINIA, CHRISTMASBERRY, ORIENTAL PHOTINIA, TOYON** (*Photinia*); **FIRETHORN** [ENGLISH, FORMOSA, SCARLET, YUNNAN] (*Pyracantha*); **PEAR** [BIRCH-LEAF, COMMON, SAND, SNOW] (*Pyrus*); **MOUNTAIN-ASH** [AMERICAN, CHINESE, COLUMNAR, EUROPEAN or ROWANTREE, KOREAN, PACIFIC, PYRAMIDAL, SHOWY, SHRUBBY CHINESE, WEEPING, WESTERN], WHITE BEAMTREE, SERVICETREE (*Sorbus*); **CHINESE STRANVAESIA** (*Stranvaesia*)

1. *Leaf Spots* — General. Spots of various sizes, shapes, and colors on the leaves. If

blackened and blasted at temperatures above 65° F. New shoots suddenly appear as if scorched by fire. Brown or blackened leaves cling to the twigs. Slightly sunken, discolored cankers on the twigs, branches, and trunk. Often followed by Black Rot and wood rots. See Figure 40 under General Diseases and Figure 67. *Control*: Avoid overstimulation of trees. Plant in fertile, well-drained soil. Follow the spray program in the Appendix (Table 10). Prune out cankers 3 to 4 inches back into healthy wood. Prune during the dormant season or in late summer if hot and dry. Apply disinfectant and then tree wound dressing (page 25) to cut surfaces. Swab pruning tools with 70 per cent denatured alcohol between cuts. A 1:1,000 solution of mercuric chloride may also be used. Fairly resistant apples: Anoka, Arkansas Black, Chestnut, Crimson Winesap, Dutchess, Early Winesap, Fenton, Fireside, Haralson, Jonadel, King David, McIntosh, Minjon, Northern Spy, Northwestern Greening, Prairie Spy, Red Delicious, Redwell, Sharon, Stayman Red, Turley, Virginia, Winesap, and Yellow Delicious. Fairly resistant crabapples: Alney, Arnoldiana, Arrow, Atrosanguinea, Coronaria charlottae, Cowichan, Dolgo,

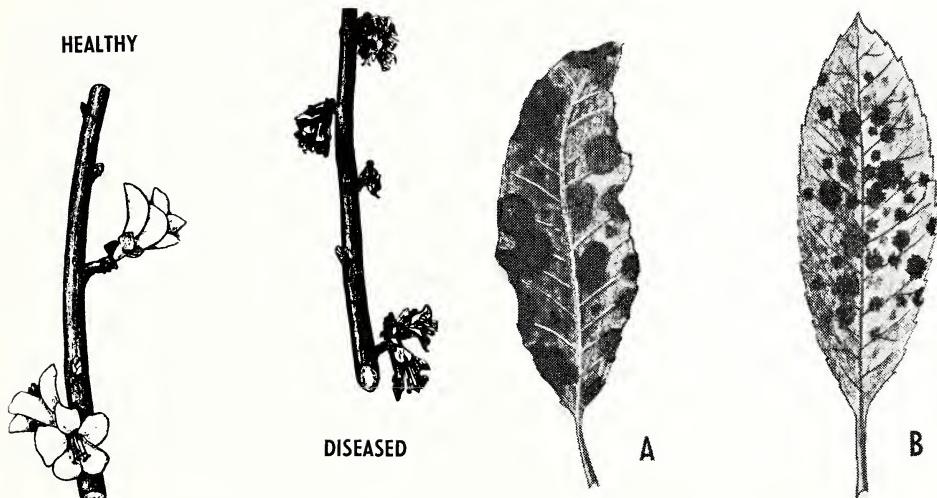


Fig. 67. Fire blight (blossom blight) of Japanese quince.

Fig. 68. A. Photinia leaf spot, B. Photinia scab.

Floribunda, Gloriosa, Hopa, Jay Darling, Mahamik, Red Silver, Sargentii, Sissipuk, Van Eseltine, and Whitney. Fairly resistant pears: Anjou, Baldwin, Carrick, Dabney, Ewart, Farmingdale, Funks Colorado, Hood, Kieffer, Lincoln, Magness, Mendel, Moe, Moonglow, Morgan, Nectar, Old Home, Oregon 18, Orient, Pine Apple, Pontotoc, Richard Peters, Seckel, Tyson, Vistica, Waite, Winter Nellis, and Wurtenburg. Numerous resistant *cotoneaster* and *pyracantha* species and varieties are also available. Check with your local nurseryman or extension horticulturist regarding the adaptability of these varieties to your area. Spraying 2 or 3 times during the bloom period with streptomycin (60 to 100 parts per million) or zineb may control the blossom blight stage. Follow the manufacturer's directions. Do not use streptomycin on *Cotoneaster racemiflora* or *Crataegus mollis*. See also (24) Fire Blight under General Diseases. More effective sprays should be available soon.

2. *Scab* — Widespread and serious. Dull, smoky spots which change to a velvety, olive-green color. Finally become brown to black and often scaly. Spots occur on

leaves and fruit as well as flower parts. Fruit may be deformed and cracked. Many young fruit and leaves drop early. See Figure 28C under General Diseases, and Figure 68B. *Control:* Collect and burn fallen leaves in autumn. Follow a regular spray program using a multipurpose fruit spray containing captan, zineb, or thiram. Dodine (Cyprex) is widely used by commercial growers. See the spray schedule in the Appendix (Table 10). *Apple* and *pear* varieties differ in susceptibility. Check with your local nurseryman. Resistant *crabapples*: Coronaria charlottae, Dolgo, Floribunda, Gloriosa, Halliana, Parkmani, Katherine, Makamik, Sargentii, Sissipuk, Van Eseltine, Zumi, and many others. Resistant *firethorn*: Yunnan.

3. *Rusts* — Widespread. Pale yellow, yellow-orange to orange-red spots (with black specks) on the upper leaf surface with a mat of creamy-white, light orange to

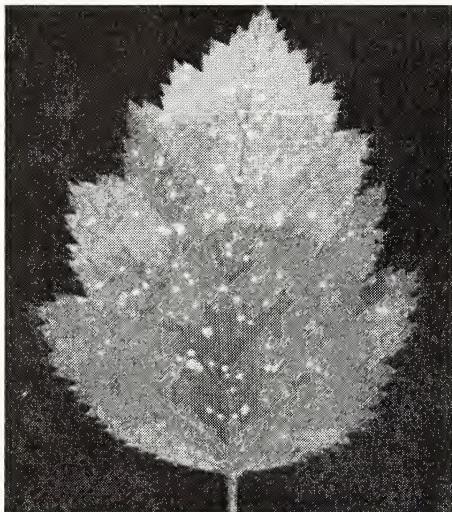


Fig. 69. Hawthorn rust (early infection).

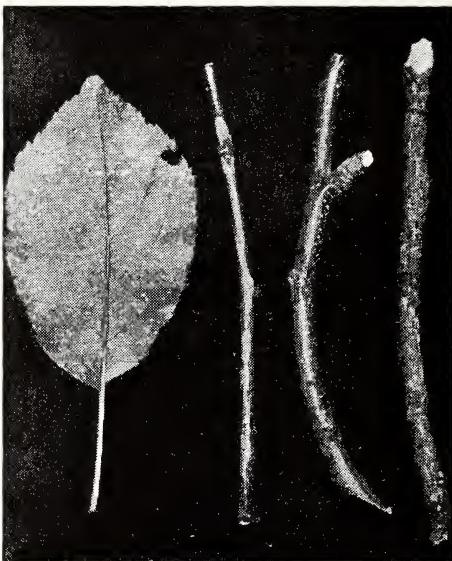


Fig. 70. Apple blotch on leaf and twigs.
(Courtesy Dr. V. H. Young)

brown tendrils forming on the corresponding underleaf surface. Heavily spotted leaves drop early. Yellowish to reddish or greenish areas on fruit, usually near the calyx end. Fruit may be distorted and drop early. Twigs and small branches may die back. See under Juniper Rusts. See Figure 22C under General Diseases and Figure 69. *Control:* Follow the regular spray program as for Scab. Add 1 tablespoonful of ferbam, zineb, or thiram (Thylate) to each gallon of spray from prebloom through second cover (see Table 10 in the Appendix). Varieties differ in resistance to the several rusts. Check with your nurseryman, county agent, extension horticulturist or plant pathologist. Resistant *apples*: Arkansas Black, Cortland, Delicious, Dutchess, Haralson, King David, McIntosh, Macoun, Northwestern Greening, Sharon, Turley, York, Winesap, and Wolf River. Destroy nearby, worthless, erect junipers, redcedars, cypress, incense-cedar, or white-cedar which show rust galls.

4. *Black Rots, Frog-eye Leaf Spot, Dieback* (primarily apple, crabapple, pear, quince,

flowering quince, hawthorn, cotoneaster, and mountain-ash) — Expanding, brown, zoned spots on the fruit which often start at insect wounds or mechanical injuries. Fruits later turn into shriveled, black mummies which cling to the twigs. Leaf spots are purple, then gray with a purple margin. Rough-barked cankers on twigs and large limbs, which often die back. Commonly follows Fire Blight. *Control:* Follow the regular spray program using captan, thiram, or zineb plus methoxychlor and malathion. Avoid wounding trees. Prune out dead wood and destroy rotted fruit mummies. Plant disease-free nursery stock.

5. *Crown Gall* — General. Rough, dark, corky gall on the trunk near the soil line, at graft union and on roots. Trees gradually lose vigor, may later die. See Figure 44A under General Diseases. *Control:* Plant disease-free stock with a smooth graft union. Avoid wounding young trees, especially near the soil line. Destroy badly infected trees. See (30) Crown Gall under General Diseases.
6. *Infectious Hairy Root, Woolly Knot* — Widespread. Most common in the nursery. Primary roots are swollen and often extend some distance from a basal gall before secondary fibrous roots are produced. Excessive growth (tufts) of these long, fine, fibrous roots gives a woolly appearance. Bacteria enter only through wounds. Small fibrous roots occur singly or in clusters at the base of the trunk, crown, or roots. May be associated with Crown Gall, with a mass of fleshy roots arising from a gall. May be confused with burr knot (a noninfectious proliferation of roots) characteristic of certain varieties. *Control:* See Crown Gall (above).
7. *Powdery Mildews* — General. Whitish-gray, powdery mold or felty patches on young leaves, buds, blossoms, and twigs. Leaves may be crinkled, curled, dwarfed, narrowed, and erect. Shoots stunted with rosette-type growth. May die back. Fruits russeted. *Control:* Where common, follow the apple spray program using sulfur or Karathane in prebloom sprays through first cover. Grow resistant varieties. Check with your county agent, extension horticulturist or plant pathologist.
8. *Sooty Molds or Blotch, Fly Speck* — General. Irregular, sootlike spots or clusters of 6 to 50 "fly specks" on the surface of fruit or twigs. Follows attacks by aphids, scales, and other insects. See Figure 26 under General Diseases. *Control:* Follow the regular spray program (Table 10 in the Appendix). Add zineb in midsummer and late summer sprays or alternate zineb and captan from second cover on. Prune to open up trees.
9. *Blotch* (apple, crabapple) — Irregular, dark brown to black, somewhat sunken spots on the fruit. Small, rough cankers may girdle the twigs and fruit spurs. Small, round, white spots occur on the leaves in which a single, black speck develops. Spots may run together. See Figure 70. *Control:* Same as for Black Rots (above). Resistant *apple* varieties: Grimes Golden, Jonathan, Stayman Winesap, and Winesap.
10. *Root Rots* — Foliage thin. Leaves often turn yellow, wither and drop prematurely. Growth is slow. Twigs and branches die back. Fruit crop often is heavy just before the tree dies. Coarse white to black mold fans or strands often grow just under the bark of the lower trunk and on root surfaces. Clumps of honey-colored mushrooms may appear near the trunk base. See Figure 47B under General Diseases. *Control:* Plant in fertile, well-drained soil where root rot of woody plants has not occurred before. Remove dying trees, including the roots. Do not replant in the same location for a number of years. Control rodents and borers. Check with your extension entomologist or county agent. Fertilize, water, and follow the recommended spray program to maintain tree vigor. Soil fumigation in the fall with carbon disulfide has been used to control Armillaria Root Rot.

(Oak-root Fungus Disease). This is a job for an experienced arborist. Carbon disulfide is inflammable and explosive.

11. *Fruit Spots and Rots* — General. Small to large, round to irregular, watersoaked, light tan to black spots on and in the fruit. Decay may later be covered with a white, blue, green, pink, black, dark brown, or gray mold. Rots often enter insect or mechanical injuries. Develop rapidly in warm, moist storage. See Figure 46A under General Diseases. *Control:* Follow the regular spray program, especially in late cover sprays. Adding zineb to sprays often helps. Control insects by using methoxychlor and malathion. Apply captan alone just before harvest. Pick early before many fruit drop. Handle fruit carefully. Store only sound, blemish-free fruit just above freezing. Apple varieties differ in resistance.

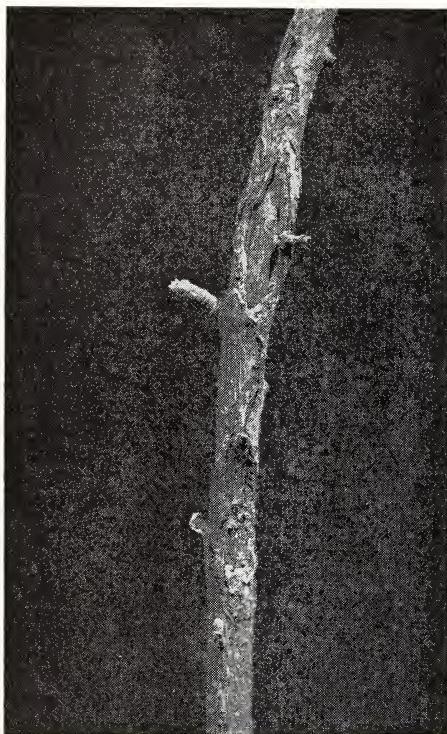


Fig. 71. Apple twig canker. (Iowa State University photo)

12. *Twig, Branch, and Trunk Cankers, Northwestern Anthracnose, Limb Blight* — Affected bark is often sunken, roughened, and discolored with wood underneath dead and discolored. Round to irregular cankers often girdle twig, limb, or trunk killing parts beyond. Entire tree may die. Cankers often show zoned ridges. Varieties differ in susceptibility. Check with your local nurseryman, extension horticulturist or plant pathologist. Most common on weakened trees low in vigor. See Figure 71. *Control:* Prune out and burn cankered twigs and branches. Cut out large cankers and sterilize cuts with household bleach or a 1:1,000 solution of mercuric chloride (see page 85 for precautions). Then paint with a tree wound dressing. Follow the regular spray program to control insects and other diseases. Avoid wounding branches and trunk. Maintain vigor by

fertilizing in the spring and watering during dry periods. Wrap young trees to prevent sunscald. Where serious, a spray of 4-4-50 bordeaux is recommended after leaves drop in the fall.

13. *Wood Rots, Butt Rots, Collar Rots, Heart Rots*—See under Birch, and (23) Wood Rot under General Diseases. Collar rot causes killing of the bark and wood underneath at or near the soil line. Trees may be girdled and killed. *Control:* Follow the regular apple spray program. Control borers by spraying the trunk and scaffold limbs with lead arsenate or DDT. Check with your county agent or extension entomologist regarding rates to use and dates of application for your area.
14. *Winter Injury, Collar Rot*—Roots, shoots, twigs, or buds may be killed. Splitting of the bark is common, especially on the trunk. See Figure 72. Generally

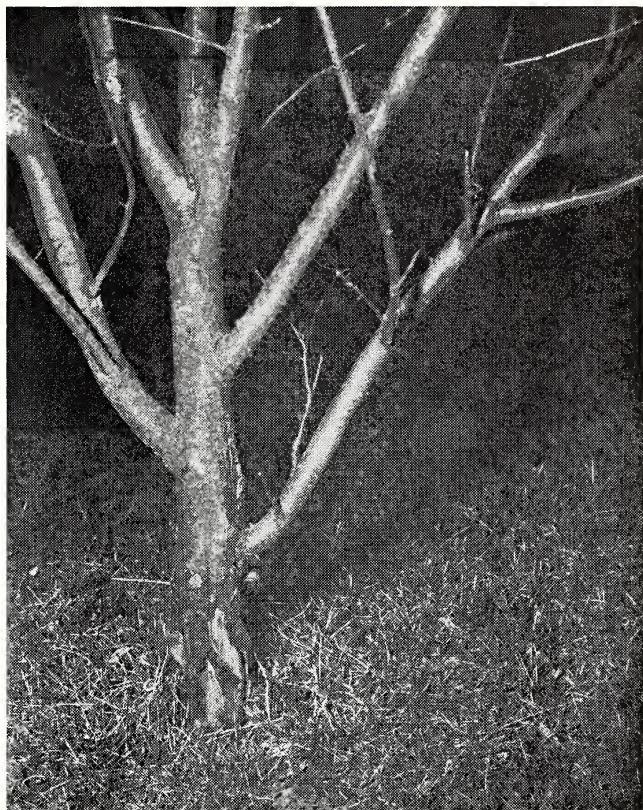


Fig. 72. Winter injury to a young apple tree.
(Iowa State University photo)

occurs on the south or southwest side. Sometimes results from failure of wood to mature in the fall, excessively low temperatures, and other factors. *Control:* Same as for Sunscald (below) and Wood Rots (above).

15. *Sunscald*—Most common on young, exposed trees. Freezing injury to the trunk and larger branches on the south or southwest side and where fruit are exposed to direct sun during hot, dry weather. Dark patches occur on pear leaves in mid-summer. *Control:* Wrap young trees and exposed larger branches (Figure 12)

with burlap, or sisalkraft paper. Follow spray program (Table 10 in the Appendix). Maintain trees in vigorous condition. Water during summer droughts. Do not prune off lower limbs for several years. Leave lowest limb on the south side.

16. *Fruit Breakdowns in Storage* (Scald, Bitterpit, Baldwin or Jonathan Spot, Black End, Brown Core or Heart, Soggy Breakdown or Soft Scald, Water Core) — May be caused by an irregular water supply during the season, general unthrifty growth, an unbalance or lack of essential soil nutrients, toxic vapors given off by the fruit in storage, freezing injury, poor storage conditions and other factors. *Control:* Check with a local grower or your extension horticulturist. Have the soil tested. Prune, water, and fertilize trees to keep them vigorous. Pick fruit when first mature. Place in a cold, well-ventilated storage place as soon as possible.
17. *Leaf Spots, Leaf Blight, Anthracnose* — Leaves variously spotted, may turn color and drop early. Fruit and twigs may be spotted. Varieties differ in susceptibility.



Fig. 73. Hawthorn leaf blight.

English *hawthorn*, especially the variety Paul's Scarlet, is very susceptible to Leaf Blight. Cockspur and Washington hawthorns are resistant. *Control:* Cut out and burn blighted twigs. Collect and burn fallen leaves. Follow the spray program as for Scab (above) or use zineb. Maneb, ferbam, Acti-dione, or phenyl mercury may be used on *hawthorn*. Apply at about 2-week intervals. Start when the new leaves appear. See figures 68A and 73.

18. *Stony Pit of Pear* — Mostly Pacific Coast states. Symptoms variable. Small, dark green areas on young fruit which later develop into deep "pits." Fruit may become deformed, gnarled, and woody at maturity. Foliage is reduced. *Control:* Destroy infected trees. Plant resistant varieties (e.g., Bartlett — a symptomless carrier) propagated from virus-free stock. Varieties showing mild symptoms include Clairogeau, Old Home, Packham's Triumph, and Waite.
19. *Witches'-broom, Black Mildew of Amelanchier* — Widespread. A mass of sturdy new shoots form witches'-brooms. Leaves usually coated with a black mold. *Control:* Cut off and burn witches'-brooms.

20. *Mistletoe* (apple, hawthorn, pear) — See (39) Mistletoe under General Diseases.
21. *Root Nematodes* (e.g., burrowing, dagger, lance, needle, pin, root-lesion or meadow, sheath, spear, spiral, stunt, stubby-root) — Tree vigor is reduced. Leaves are stunted. Terminal growth may die back. May be associated with root rot and "little leaf" or rosette. Small, dead, dark spots on the white rootlets. Affected roots may be stunted and distorted. *Control:* Keep trees as vigorous as possible through feeding, pruning, and watering. Fumigate soil (pages 440-44) before re-planting.
22. *Root-knot* — Common in southern states, especially where cover crops have been used. Knots and swellings on the roots which may be confused with those made by woolly apple aphids, crown gall, and hairy root. Plants may be stunted. Foliage yellowish with scorching of the leaf margins. Leaves may wilt temporarily in hot, dry weather. *Control:* Same as for Root Nematodes (above).
23. *Apple Mosaics* — Leaves variously mottled (light and dark green mosaic) with many small, irregular, white to creamy yellow flecks, spots, and patches. Leaf veins may be banded by white or pale yellow stripes. Symptoms extremely variable on a single tree or even a single branch. A few mottled leaves may appear on an otherwise healthy-appearing branch. Large numbers of leaves may drop early. Viruses are spread by underground root grafts. *Control:* Destroy wild apples near the orchard. Plant certified, virus-free stock. Follow the spray program in Table 10 in the Appendix.
24. *Apple Flat Limb* — Slight depression or furrow on twig or limb which becomes more pronounced with age. Bark over the depression is smooth. Affected branches are often brittle; may break under a fruit load. *Control:* Same as for Apple Mosaics (above).
25. *Apple Rubbery Wood* — Twigs and smaller branches bend over or "weep" from their own weight. Wood is soft and "cheesy" in texture when cut. Affected trees are stunted, less vigorous than normal. Symptoms often restricted to certain branches of a tree. Fruit appear normal, but yield is reduced. Some varieties are symptomless carriers of the virus. *Control:* Same as for Apple Mosaics (above).
26. *Zinc Deficiency, Little Leaf* — Common in alkaline soils on apple and pear. Whorls of small, stiff, yellowish, sometimes mottled leaves (called rosettes) at tips of current season's growth. Twigs are usually spindly and stunted. May die back after the first year. *Control:* Check with your county agent or extension horticulturist. They may recommend a dormant spray of zinc sulfate.
27. *Internal Cork, "Drought Spot" or Dieback, Boron Deficiency* (apple, pear) — Widespread and may be serious in local areas. Large, more or less superficial dead areas, which become russeted and cracked, usually appear before the apple fruit is half grown. Brown corky spots form in the fruit flesh. Twigs die back in late summer. Leaves on the current season twigs are yellowish with red veins. Somewhat cupped and distorted. Dead areas develop at the tips and margins. Normal buds fail to develop or make poor growth. Twigs may form witches'-brooms. Pear blossoms may be blasted. *Control:* Add borax to the soil around trees or spray with boric acid (0.1 to 1 per cent) following the recommendation of your extension horticulturist or a local grower. Spraying during bloom with Solubor has also given good results on apple.
28. *Leaf Scorch, Potassium or Calcium Deficiency* (apple, pear) — Leaves on many varieties develop marginal scorching, browning, and shriveling about the middle of the growing season. A yellow or red discoloration is characteristic of certain varieties. Twigs are slender and stunted. May die back. Fruit poor, pale in

color and "woody." Similar scorching may be caused by drought, strong dry winds and a water-logged or "shallow" soil. *Control:* Have the soil tested and apply a potash or calcium-containing fertilizer as recommended. Varieties differ greatly in susceptibility.

29. *Pear Decline* — Widespread and serious in the Pacific Northwest. Plants are stunted and make little or no new growth. Trees gradually decline, wilt, and die. Foliage on affected trees is sparse and often turns a dull to bright red prematurely. Bartlett, D'Anjou and other varieties on oriental and imported French rootstocks are most susceptible. Failure or poor union between the scion and rootstock. Roots die back. The cause is still in doubt but poor cultural practices, unusual growing conditions, soil fungi, and nematodes may be contributing factors. An insect- or mite-borne virus may also be involved. *Control:* Replant using resistant rootstocks (e.g., virus-free Old Home). Check with your extension or state plant pathologist regarding the latest available information.
30. *Thread Blight* — Southeastern states. See under Walnut.
31. *Felt Fungus* (apple, hawthorn, pear) — Southern states, on neglected trees. See under Hackberry. *Control:* Follow the recommended spray program.
32. *Leaf Blister, Witches'-broom* (amelanchier) — California. See (10) Leaf Curl under General Diseases.

APRICOT — See Peach

AQUILEGIA — See Delphinium

ARABIAN-TEA — See Bittersweet

ARABIS — See Cabbage

ARACHIS — See Peanut

ARALIA — See Acanthopanax

**ARAUCARIA, NORFOLK ISLAND PINE, MONKEYPUZZLE TREE,
BUNYA-BUNYA (*Araucaria*)**

1. *Branch Blight, Dieback* — Tips of lower branches die back. Later, entire branches are killed. Tip ends bend and break off. The disease gradually spreads upward killing the tree. *Control:* Prune off and burn infected branches when first noticed. Spraying with a fixed copper fungicide during spring and fall rainy periods may be beneficial.
2. *Crown Gall* — Smooth, roughly circular galls, up to an inch in diameter, occur at or near the soil line. *Control:* Avoid wounding tree base when cultivating, mowing, etc.
3. *Root Rot* — See under Apple, and (34) Root Rot under General Diseases.
4. *Leaf Spots* — Leaves spotted. Unimportant.

ARBORVITAE — See Juniper

ARbutus, ARCTOSTAPHYLOS — See Blueberry

ARCTOTIS — See Chrysanthemum

ARECASTRUM — See Palms

ARENARIA — SEE Carnation

ARENGA — See Palms

ARGEMONE — See Poppy

ARGYREIA — See Morning-glory

ARISAEMA — See Calla

**ARISTOLOCHIA, BIRTHWORT, DUTCHMANS-PIPE, VIRGINIA SNAKEROOT
(*Aristolochia*)**

1. *Leaf Spots* — Spots of various colors, sizes, and shapes on leaves. *Control:* Apply ferbam, zineb, or maneb several times, 10 to 14 days apart, starting when the leaves are $\frac{1}{4}$ inch out.
2. *Gray-mold Blight* — See (5) Botrytis Blight under General Diseases. *Control:* Spray as for Leaf Spots.
3. *Root Rot* — See under Geranium. Plant in light, well-drained soil. Avoid over-watering.

ARMERIA — See Sea-lavender

ARNICA — See Chrysanthemum

ARONIA — See Apple

ARROWROOT — See Rabbit Tracks

ARROWWOOD — See Viburnum

ARTEMISIA — See Chrysanthemum

ARTICHOKE — See Lettuce

ARTILLERY-PLANT (*Pilea*)

1. *Leaf Spots* — Round to angular, gray or tan spots on the leaves. Spots may enlarge and run together forming large blotches. Older infected leaves may turn yellow and drop early. *Control:* Pick off and burn infected leaves. Space plants. Indoors, keep water off the foliage and avoid high humidity. If needed, spray several times, 10 days apart, using fixed copper or maneb.
2. *Powdery Mildew* — Grayish-white mold blotches on the leaves. *Control:* If serious enough, apply sulfur or Karathane several times, 10 days apart.
3. *Root Rot* — See under Geranium, and (34) Root Rot under General Diseases. *Control:* Indoors, plant in well-drained, sterilized soil. See pages 437-44 in the Appendix. Avoid overwatering and overfertilizing.
4. *Root-knot* — See (37) Root-knot under General Diseases.

ARUNCUS — See Rose

ASCLEPIAS — See Butterflyweed

ASCYRUM — See St.-Johns-wort

ASH [BLACK or HOOP, BLUE, EUROPEAN, FLOWERING, GREEN, OREGON, RED, VELVET, WHITE] (*Fraxinus*); FRINGETREE [AMERICAN, CHINESE or ORIENTAL] (*Chionanthus*); FORESTIERA, SWAMP-PRIVET (*Forestiera*)

1. **Rusts** (ash, forestiera) — General. Twigs and petioles may be swollen. Leaves are distorted. Bright yellowish-orange, powdery pustules appear on affected parts. Infected leaves may wither and drop early. Another rust on forestiera, causes reddish-brown to black, powdery pustules on the leaves. See Figure 74. *Control:*

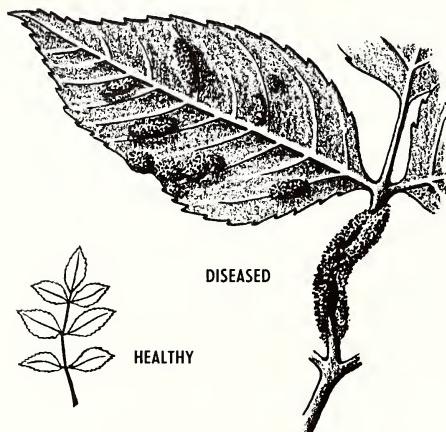


Fig. 74. Ash rust.

Avoid growing ash and forestiera where the alternate hosts, cord and marsh grasses (*Spartina* spp.), are abundant. If serious enough, spray three times at 2-week intervals, starting about when apples are in bloom. Use ferbam, zineb, ziram, dichlone, bordeaux mixture, or sulfur.

2. **Leaf Spots, Anthracnose** — Widespread during wet springs. Small to large, round to irregular spots and blotches of various colors develop on the leaves, particularly between the veins and along the edges. Leaves may be distorted, wither, and drop early. *Control:* Collect and burn fallen leaves. If practical, spray several times, 10 days apart, starting as the buds swell. Use zineb, ferbam, phenyl mercury, ziram, captan, or fixed copper.
3. **Leaf Scorch** (primarily ash) — Margins of leaves turn brown following hot, dry, windy weather. Dead areas advance inward between the leaf veins. Most prevalent throughout the top of the tree or on the windward side during July and August. *Control:* Prune to open up the tree. Fertilize to increase vigor. Water during dry periods.
4. **Twig Blight, Dieback, Branch and Trunk Cankers** — General. See under Maple and Elm. *Control:* Prune out and burn infected twigs and branches. Keep trees growing vigorously through fertilizing, watering during summer droughts, and controlling other disease and insect pests. Avoid wounding bark. Paint wounds promptly with a tree paint.
5. **Wood Rots** — Widespread. See under Birch, and (23) Wood Rot under General Diseases.
6. **Crown Gall, Hairy Root** (ash) — See under Apple, and (30) Crown Gall under General Diseases.

7. *Powdery Mildews* — Widespread from late summer on. Grayish-white, powdery, mold patches on the leaves and young twigs. Leaves may turn yellow and drop early. *Control:* See under Birch.
8. *Root Rot* — See under Apple.
9. *Verticillium Wilt* (ash) — See (15B) Verticillium Wilt under General Diseases.
10. *Sooty Mold, Black Mildew* — Black mold patches on the leaves. *Control:* Spray to control insects. Use DDT and malathion plus a fungicide.
11. *White Ash Flower Gall* — Clusters of very irregular, bunched, brown galls on male (staminate) flowers. The galls, caused by minute mites, are conspicuous during the winter months. *Control:* Apply malathion after the buds swell and before the new growth emerges in the spring.
12. *Root-knot* — See under Peach.
13. *Mistletoe* — See (39) Mistletoe under General Diseases.
14. *Felt Fungus* — Southeastern states. Purple-black, feltlike growth on the bark. Associated with scale insects. See under Hackberry.
15. *Seedling Blight* — See under Pine.

ASIMINA — See Pawpaw

ASPARAGUS, GARDEN; ASPARAGUS-FERN or LACE-FERN, "SMILAX" OF FLORISTS, SPRENGER ASPARAGUS (Asparagus)

1. *Rust* (asparagus) — General. Yellow to orange-red, then black, powdery pustules on the stems and leaves. Top may die early, reducing next year's crop. *Control:* Plant normally rust-resistant Mary Washington or Martha Washington and California 500. Destroy volunteer plants or wild asparagus near producing beds. Cut and burn tops in the fall. Asparagus species vary greatly in resistance. If practical, apply zineb or maneb just after harvest and continue at 10-day intervals to midsummer. Start spraying young, uncut beds in midspring. Acti-dione may also be used following the manufacturer's directions. Elgetol or Krenite may be used in the fall or spring on dormant plants. Follow the manufacturer's directions.
2. *Fusarium Wilt, Yellows, Foot and Root Rot* — Plants stunted, turn yellow, wilt, and gradually die (decline). Spears gradually decrease in size and number. Roots and shoot bases show red or reddish-brown streaks and flecks when cut through. Poor stand. *Control:* Plant treated seed (Table 13) or healthy stock in a clean, well-drained, well-prepared soil as far from old beds as possible. Plow under unproductive beds. Keep plants growing vigorously by watering and fertilizing.
3. *Branchlet Blight, Stem Cankers, Dieback* (asparagus, asparagus-fern) — Branchlets wither and fall. Plants may die back to the crown. Pale cankers, often sprinkled with black dots, may occur on the stems. *Control:* Collect and burn tops in the fall. Where practical, apply maneb or zineb sprays before wet periods, 7 to 10 days apart. Avoid overwatering. Plant in sterilized (fumigated) soil, where practical.
4. *Crown Gall* — Irregular, thick, pale green, fleshy gall at base of stem. See (30) Crown Gall under General Diseases. *Control:* Plant healthy stock in soil which has not had the disease in 3 years or more. Dig up and destroy infected plants.
5. *Leaf (Branchlet and Stem) Spots* — Small, generally oval to elliptic, spots on stems, branches, and needles. Spots are tan to gray with a reddish-brown border. Needles and youngest branches may die and drop early. *Control:* Same as for Rust (above). Keep plants growing vigorously by watering and fertilizing. Apply zineb, maneb, or captan at weekly intervals during rainy periods.

6. *Stem Rots, Crown Rot* — Watery, soft spots or rot of shoots. Often near the soil line. Tissues may be covered with a gray, cottony, or blue-green mold growth. Spots often enlarge rapidly. Tops wilt, may collapse. See (5) Botrytis Blight, (21) Crown Rot, and (29) Bacterial Soft Rot under General Diseases. *Control:* Keep the soil surface loose and dry. Carefully dig up and destroy infected plants and several inches of surrounding soil. Plant in well-drained soil. Avoid overcrowding and wounding stems. Applying Terraclor (PCNB) to the soil surface before rots start may help. See under Bean. Protect seedlings for winter by slight hilling in autumn. Avoid injury when harvesting.
7. *Root-knot* — See under Bean, and (37) Root-knot under General Diseases.
8. *Chlorosis* — Normal green color fades to yellow. *Control:* Avoid overwatering and too acid or alkaline soil.
9. *Verticillium Wilt* — See (15B) Verticillium Wilt under General Diseases.
10. *Root Rots* — See (34) Root Rot under General Diseases. May be associated with nematodes (e.g., lance, needle, pin, spiral, stem, stylet or stunt).

ASPARAGUS-BEAN — See Pea

ASPARAGUS-FERN — See Asparagus

ASPEN — See Poplar

ASPIDISTRA, CAST-IRON PLANT (*Aspidistra*)

1. *Chlorosis and Root Rot* — Leaves turn yellow and die. *Control:* Avoid overwatering and too much light. Plant in well-drained soil.
2. *Leaf Spots, Leaf Blight, Anthracnose* — Spots of various sizes, shapes, and colors on the leaves. If the disease is severe, leaves may wither and die. *Control:* Pick off and burn infected leaves. Spray as for Leaf Spots of Chrysanthemum if that is practical.

ASPLENIUM — See Ferns

ASTER (CHINA- and HARDY) — See Chrysanthemum

ASTILBE

1. *Powdery Mildew* — See (7) Powdery Mildew under General Diseases.
2. *Fusarium Wilt* — Plants turn yellow, wilt, and die. *Control:* Set out healthy plants in clean or sterilized soil. Avoid injuring roots and crown.

ATAMASCO-LILY — See Daffodil

ATHYRIUM — See Ferns

AUBRETIA — See Cabbage

AUCUBA, JAPANESE AUCUBA, GOLDDUST-TREE (*Aucuba*)

1. *Leaf Spots* — Brown or black spots, often zoned. Mostly near margins of leaves. Infected leaves may wither and drop early. *Control:* Spray several times, 10 days apart, using zineb, maneb, or fixed copper. Combine with an insecticide (e.g., DDT or malathion) to kill scales, if these insects are present.
2. *Gray-mold Blight* — Indoor problem where moist. Twigs blighted and killed back. Affected areas may be covered with a dense gray mold in damp weather. *Control:*

Space plants. Keep the humidity down. Increase air circulation. Keep water off the foliage.

3. *Anthracnose, Wither Tip* — Spots develop on leaves and flowers. Stem cankers cause tips of branches to wilt and die back. *Control:* Pick or cut off affected plant parts. Apply zineb, captan, or maneb before wet periods.
4. *Verticillium Wilt* — See (15B) Verticillium Wilt under General Diseases.
5. *Frost or Winter Injury* — Easily mistaken for disease. Young leaves are nipped by spring frosts. Older leaves turn brown in winter in northern states unless protected. Check with your local nurseryman or extension horticulturist regarding winter protection.

AUTUMN-CROCUS — See *Colchicum*

AVENS — See *Rose*

AVOCADO, REDBAY, SWAMPBAY (*Persea*); CAMPHOR-TREE, CINNAMON-TREE (*Cinnamomum*); SPICEBUSH (*Lindera* or *Benzoin*); CALIFORNIA-LAUREL (*Umbellularia*); POND-SPICE (*Litsea*); SASSAFRAS

1. *Root Rots* — Cosmopolitan on avocado and camphor-tree. Trees gradually or suddenly decline in vigor and productivity. Leaves are pale, tend to wilt, and drop early. Branches die back. Trees may die. Often serious in wet, poorly drained soils. See under Apple. *Control:* Treat suspected avocado seed before planting by soaking for 30 minutes in hot water (120° to 122° F.). Then wash in cold water and dry. In California, Texas, and Florida, grow resistant strains of avocado (e.g., Duke or Scott rootstocks) developed for planting in infested soils. Plant in deep, well-drained soil (fumigated, if possible) where root rot has not been present before. Indoors plant in sterilized soil. See "Soil Treatment Methods and Materials" in the Appendix. Maintain a uniform soil moisture supply.
2. *Wood, Heart, Trunk and Collar Rots, Trunk Cankers* — Widespread. Trees may gradually decline in vigor or die suddenly due to a rotting and girdling of the trunk (collar rot), or encircling cankers. *Control:* See under Birch and Dogwood. Avoid covering the bud union with soil.
3. *Anthracnose or Black Spot, Leaf Spots or Blotch, Leaf and Fruit Scab* — General. Small to large, round to irregular, spots and blotches on the leaves. Leaves or branch tips may wilt and wither. Spots may also occur on avocado flowers and fruit. Fruit may appear russeted. *Control:* Collect and burn fallen leaves and spotted or scabby fruit. Otherwise same as for Twig Canker (below). *Avocado* varieties resistant to Scab: Booth 1, Collinson, Fuchsia, Itzamna, Linda, and Waldin. Varieties also differ in resistance to Cercospora Spot.
4. *Twig and Branch Cankers, Dieback* — Widespread. Foliage on twigs and branches may wilt and wither. Twigs and branches die back from small to large, girdling, discolored cankers. *Control:* Cut off and burn affected plant parts. Avoid wounds. Paint over promptly with a tree wound dressing. Spray during rainy periods using ferbam, zineb, maneb, captan, or fixed copper. Where avocados are grown commercially, follow the recommended spray schedule for your area. Check with your county agent or extension plant pathologist.
5. *Oedema* (avocado) — Indoor problem. Small "scabby" or wartlike growths develop on the upper leaf surface. These later crack open and become reddish-brown in color. *Control:* Avoid overwatering during moist, overcast weather. Increase air circulation and temperature.

6. *Verticillium Wilt* (avocado, camphor-tree, sassafras) — Leaves on one to several branches or the entire plant, wilt, turn brown, wither, and remain on the tree. A brown discoloration may be seen in the wood just under the bark on the branches and trunk. Trees may die or recover completely. *Control:* See under Maple.
7. *Sun-blotch* (avocado) — Long, narrow, shallow streaks develop near the stem end of the fruit. The streaks are whitish or yellow in green fruits and red or purplish-red on purple or black varieties. Yellow streaks occur on green stems and branches. Older stems are uneven and rough. Shoots prostrate, willowy, twisted, and lack vigor. *Control:* Plant seed, scion wood, and rootstocks from virus-free trees.
8. *Little Leaf, Rosette, Zinc Deficiency* (avocado) — Leaves severely mottled at edges. Leaf tips may appear scorched without mottling. Avocado fruit may be deformed. If prolonged, branches may die back. *Control:* Sprays of zinc sulfate (8 ounces in 10 gallons) and hydrated lime (4 ounces in 10 gallons), applied soon after new growth appears, are often used. With many soils a single application of zinc chelate has given protection for 3 years or more. Check with your county agent or extension horticulturist.
9. *Powdery Mildew* — Powdery, white mold growth on underside of leaves mostly on trees growing in shaded, damp locations. Shoot tips may die back. *Control:* If serious enough, apply two Karathane sprays, 10 days apart.
10. *Fruit Spots and Rots* — Small to large, enlarging spots on *avocado* fruit. Fruit may appear russeted, scabby, or cracked. May develop on fruit in tree or after harvest. Fruit often covered with black, blue, or white mold growth. *Control:* Follow the recommended spray schedule for your area (see under Twig Canker above). Keep trees well pruned. Pick fruit early and store at the recommended temperature and humidity. Check with your extension horticulturist.
11. *Black Mildews, Sooty Blotch* (avocado, California-laurel, camphor-tree, redbay, sassafras, spicebush, swampbay) — Primarily in the Gulf states and California. Black mold patches on foliage and branches. *Control:* Spray as for Twig Canker (above). Control insects with malathion sprays.
12. *Root-knot and Other Root-Feeding Nematodes* (burrowing, dagger, pin, ring, root-lesion or meadow, sheath, sphaeronema, stubby-root) — See under Peach. Avocado is resistant to Root-knot. Associated with decline and sickly foliage.
13. *Mistletoe* — See (39) Mistletoe under General Diseases.
14. *Yellows* (sassafras) — Leaves dwarfed and rolled. Branch tips are bunched and fasciated. *Control:* None suggested.
15. *Chlorosis, Mottle Leaf* — Mostly in alkaline soils. Leaves turn yellow except for the veins. See under Maple. Avocado varieties differ in resistance.
17. *Seedling Blights* — See under Pine.

AXONOPUS — See Lawnglass

AZALEA — See Rhododendron

AZARA

1. *Stem Rot* — See (21) Crown Rot under General Diseases. *Control:* Dig up and destroy infected plants. Set new plants in clean or sterilized soil (pages 437-44).

AZTEC LILY — See Gladiolus

BABIANA — See Iris

BABY-BLUE-EYES — See Phacelia

BABYSBREATH — See Carnation

BABYTEARS VINE (*Helxine*)

1. *Leaf Spot* — See (1) Fungus Leaf Spot under General Diseases.
2. *Rust* — See (8) Rust under General Diseases.
3. *Powdery Mildew* — See (7) Powdery Mildew under General Diseases.

BACHELORS-BUTTON — See Chrysanthemum

BALDCYPRESS — See Pine

BALLOONFLOWER — See Bellflower

BALM — See Salvia

BALM-OF-GILEAD — See Poplar

BALSAM [GARDEN, SULTAN]; PATIENCE PLANT (*Impatiens*)

1. *Leaf Spots, Anthracnose* — Small to large spots or blotches on leaves. Leaves and young shoots may be blighted. *Control:* Apply zineb, maneb, or captan. Burn tops in the fall.
2. *Wilts (Bacterial and Verticillium)* — See (15B and C) under General Diseases. *Control:* Destroy infected plants. Do not replant in the same soil without first treating with heat or chemicals (pages 437-44).
3. *Stem Rots* — Watery, soft rot at the soil line. Later covered with a cottony mold. *Control:* Same as for Wilts.
4. *Downy Mildew* — See (6) Downy Mildew under General Diseases.
5. *Rust* — Generally unimportant in gardens. See (8) Rust under General Diseases. Alternate hosts include *Adoxa* and wild grasses (*Agrostis* and *Elymus*).
6. *Root-knot* — Southern states. See (37) Root-knot under General Diseases.
7. *Damping-off* — Seedlings wilt and collapse. *Control:* Sow seed in clean, well-drained soil or a sterile medium. Avoid overwatering.
8. *Root Rot* — See under Chrysanthemum. May be associated with nematodes (e.g., dagger, root-knot).

BALSAM-APPLE, BALSAM-PEAR — See Cucumber

BALSAMROOT (*Balsamorhiza*) — See Chrysanthemum

BALTIC IVY — See Ivy

BANEBERRY — See Anemone

BAPTISIA — See False-indigo

BARBERRY [BLACK, BOX, GREEN-LEAF, DARWIN, DWARF MAGELLAN, JAPANESE or THUNBERGS, KOREAN, MENTOR, MINIATURE, NEUBERT, RED-LEAF JAPANESE, ROSEMARY, THREESPINE, UPRIGHT JAPANESE, WARTY, WILSON, WINTERGREEN] (*Berberis*); VANILLALEAF (*Achlys*); BLUE COHOSH (*Caulophyllum*); MAHONIA [CASCADES, CLUSTER, CREEPING, LAREDO, LEATHERLEAF or CHINESE, OREGON-GRAPE or HOLLYGRAPE] (*Mahonia*)

1. *Verticillium Wilt* (barberry) — Leaves wilt, turn brown or red, wither, and fall on one or more branches. Inside of stems show green to brown streaks when

cut. Entire plants may later die. *Control:* Dig up and burn severely infected plants. Do not replant in the same location for several years. Plant in well-drained soil. Avoid wounding roots and stem. Fertilize and water to stimulate vigor.

2. *Bacterial Leaf Spot and Twig Blight* (barberry) — General. Small, round to irregular, dark green, water-soaked spots which later turn a purplish to reddish-brown color. Twigs may die back. *Control:* Prune out and burn infected twigs. Apply several fixed copper, bordeaux (4-4-50), or streptomycin sprays (100 parts per million), 10 days apart, starting when the new leaves open.
3. *Anthracnose, Fungus Leaf Spots, Leaf Blotch* — Tan, brown, or purple spots on the leaves. Often with a distinct margin. *Control:* If serious enough, apply several sprays, 7 to 10 days apart, using copper, zineb, manebe, or ferbam.
4. *Powdery Mildew* (barberry) — Whitish powdery mold on leaves. *Control:* If serious enough, apply several sprays, 7 to 10 days apart, using sulfur or Karathane.
5. *Root-knot* — See (37) Root-knot under General Diseases.
6. *Rusts* — Small, bright orange to blood-red spots on the upper leaf surface in the spring. The underside of infected leaves shows golden-yellow, cuplike growths with fringed margins, or minute, brownish, powdery pustules. Cultivated *barberries* are highly resistant or immune to the serious stem rust of cereals and grasses of which



Fig. 75. Stem rust on barberry. (USDA photo)

the common (European) barberry, Oregon-grape, and other Mahonias are the alternate hosts. In many states it is unlawful to grow rust-susceptible varieties of barberry or Mahonia. Check with your nurseryman or extension plant pathologist before planting. See Figure 75. Other alternate hosts of Mahonia rusts include Koeleria and Oxalis.

7. *Root Rot* — See under Apple and (34) Root Rot under General Diseases. Avoid heavy, poorly drained, compact soil. Space plants for good aeration and light.

8. *Mosaic* (barberry) — Irregular pattern of reddish blotches on the leaves. *Control:* Destroy affected plants.
9. *Cankers, Dieback, Heart Rot* — Twigs and branches die back. See under Maple. *Control:* Cut out and burn infected parts. Spray as for Anthracnose (above).
10. *Gray-mold Blight* (barberry, blue cohosh) — Blossoms and leaves are blighted. May be covered with a gray mold in damp weather. *Control:* Same as for Anthracnose (above).
11. *Leaf Scorch, Scald* (mahonia) — Leaves scorched by winter winds and sun in northern states. *Control:* Plant in protected locations, where adapted. Erect canvas or burlap barriers to ward off winter winds.
12. *Root-feeding Nematodes* (e.g., dagger, pin, ring, spiral, stem, stylet or stunt) — Associated with sickly, stunted plants in a state of decline. *Control:* Same as for Root-knot (above).

BASIL, BASILWEED — See Salvia

BASKETFLOWER — See Chrysanthemum

BASSWOOD — See Linden

BAYBERRY — See Waxmyrtle

BEACH PEA — See Pea

BEAKED CORNSALAD — See Valerian

BEAMTREE — See Apple

BEAN [ADZUKI, GARDEN (vine or pole, bush or dwarf), KIDNEY, LIMA, MUNG, SIEVA or CIVET, SCARLET RUNNER, TEPARY, TEXAS] (Phaseolus); JACKBEAN, SWORDBEAN (Canavalia)

1. *Bacterial Blights* — General. Water-soaked blotches on leaves, stems, and pods which soon enlarge and become irregular and brown or reddish-brown areas with yellowish margins. Leaves become dry, brittle, and ragged. Stems may be girdled, dwarfing, or killing plants. Diseased seed may be shrunken, discolored, and show a varnish-like coating or appear healthy. Most severe after hail or frost damage. See Figure 16A under General Diseases. *Control:* Plant only certified, weakened. See Figure 21A under General Diseases and Figure 95. *Control:* Avoid plants. Keep down weeds. Space plants. Plant in well-drained soil. Maintain three-year rotation. Collect and burn or bury tops after harvest. Resistant bean varieties to one or more blights: Blue Lake, Cornelius 14, Fullgreen No. 1, Great Northern No. 1, Kentucky Wonder, Michelite, Pinto, Red Mexican, Richmond Wonder, Robust, Starland Wax, Tendergreen, and Tenderlong 15. *Scarlet runner beans* are normally resistant to bacterial blights. Plant lima beans as far away from lilac, pear, etc., as possible.
2. *Bacterial Wilts* — Symptoms may closely resemble those of Bacterial Blights. Plants are stunted. Leaves hang limply during the heat of the day. Later turn brown and drop off. Infected seeds are yellow and wrinkled. Often shrunken and "varnished." Seedlings or older plants wilt and die. *Control:* Plant certified, western-grown seed. Rotate. Cultivate shallowly. Plant resistant bean varieties: Black Wax, Crystal White Wax, Golden Wax, Great Northern No. 1, Kentucky Wonder, Michelite, Monroe, Refugee Wax, Tendergreen, and Valentine. *Lima beans* are generally resistant.
3. *Mosaics, Mottle, Yellow Dot and Stipple, Streak* — General. Leaves usually puckered, dwarfed, crinkled, and curled downward. Show irregular, yellow or light and

dark green mottling. Plants often stunted, bunched, and a sickly yellow color. Produce few pods. Pods often deformed, rough, shiny (or greasy), and stunted. See Figure 32C under General Diseases. *Control:* Plant certified, virus-free seed. Resistant bean varieties to two or more mosaic-type viruses: Blue Lake, Choctaw, Columbia Pinto, Contender, Corneli 14, Earligreen, Extender, Florigreen, Garden Green, Great Northern 1140, etc., Harvester, Idaho Bountiful, Idagreen, Ideal Market, Improved Brittle Wax, Improved New Stringless, Kentucky Wonder, Mountaineer, Red Shellout, Resistant Cherokee, Rialto, Sanilac, Sensation Refugees No. 1066 and 1071, Seminole, Shipper, Small White 51 and 52, Stringless Blue Lake (Clara Val, F-M 1 and No. 231), Tenderbest, Tendercrop, Tenderlong 15, Tenderwhite, Topcrop, Topmost, Wade, Wadex, White Seeded Contender, and Wisconsin Refugee. *Lima bean* varieties resistant to mosaic: Burpee Best, Burpee Improved, Carpenteria, Challenger, Detroit Mammoth, Dreer Bush, Dwarf Large White, Early Jersey, Fordhook, Improved No. 243, King of the Garden, Leviathan, McCrea, New Wonder, and Seibert. *Scarlet runner beans* are resistant to a wide range of bean viruses. Keep down weeds. Control aphids which transmit the viruses. Apply malathion at weekly intervals. Grow beans as far away from alfalfa, clover, sweet clover, gladiolus, lupine, and possibly corn as practical.

4. *Root Rots, Stem Cankers* — General. Plants sickly and stunted with few pods. May wilt and die. Leaves turn yellow and drop early. Roots and stem near the soil line are discolored and decayed. May be associated with nematodes. See (34) Root Rot under General Diseases. *Control:* Plant certified, disease-free seed, treated with thiram, chloranil, or captan (see Table 13 in the Appendix). Plant in warm, well-drained, fertile soil where beans or related crops have not grown for 6 years or more. Cultivate shallowly. Keep plants growing vigorously. Burn crop debris after harvest. *Bean* varieties resistant to Fusarium Dry Root Rot: Blue Pod Medium, Flat Marrow, Hodson Wax, Michelite, Monroe, and Robust. *Scarlet runner beans* are also resistant to this root rot.
5. *White Mold, Watery Soft Rot, Crown Rot, Sclerotinia Wilt* — General. Soft, water-soaked spots on leaves, stems, and pods which soon enlarge and become covered with a cottony mold. Stem just below the soil line is often water-soaked and darkened. Affected parts become mushy, wilt, and die. Most common when foliage is dense. *Control:* Avoid overcrowding and overhead sprinkling. Keep down weeds. Plant in well-drained soil. Apply Terraclor (PCNB) at first bloom or before vines shade ground. Rotate. Carefully dig up and burn affected plants. Partially resistant bean varieties: FM 1, Golden Wax and Stringless Green Pod.
6. *Anthracnoses* — General except in dry areas in the western states. Sunken, reddish-brown to nearly black spots or blotches on pods and seed. Veins on the underside of leaves develop blackened portions. Long, dark red cankers develop on the stems. May enlarge and girdle stems. Young plants may die. *Control:* Same as for Bacterial Blights (above). Plant in well-drained soil and keep down weeds. No good resistant bean varieties are yet available to all fungus strains. Where practical, spray as for Downy Mildew (below), especially in the seedbed, or use ferbam. Control insects by using a multipurpose spray containing malathion and DDT, methoxychlor, or rotenone. Do not use DDT within 30 days of harvest.
7. *Rust* — General. Infrequent on lima bean and scarlet runner bean. Small reddish-brown, then chocolate-brown to black, pustules on any aboveground plant parts late in the season. Mostly on underleaf surface. Leaves may yellow, wither, and fall early. Yield is reduced. See Figure 22B under General Diseases. *Control:* Same as for Bacterial Blights (above). *Bean* varieties resistant or tolerant to many rust races: Borinquen, Criolla, Florigreen, Golden Gate Wax, Golden "No Wilt," Great Northern 1140, Green Savage, Harvester, Hawaiian Wonder, U.S. No. 4

Kentucky Wonder, Kentucky Wonder Rust Resistant, Kentucky Wonder Wax, Lualualei, Morse Pole No. 191, Potomac, Rialto, Rust-proof Golden Wax, Seminole, Stringless Blue Lake No. 228 and 231, Tendergreen, U.S. Pinto No. 5 and 14, and Wade. Where necessary, make several weekly applications of maneb, zineb, ziram, thiram, chloranil, dichlone, or sulfur, starting when rust is first evident. If dusting, make applications twice weekly.

8. *Powdery Mildews* — Widespread. Whitish, powdery, mold patches on the leaves, stems, and young pods. Young leaves may curl, turn yellow, shrivel, and fall early. Pods may turn black. *Control*: Rotate. Burn or plow under plant debris after harvest. Keep down weeds. Apply Karathane, sulfur, or Acti-dione one to four times weekly starting when mildew is first seen. Normally resistant bean varieties: Columbia Pinto, Contender, Dixie Belle, Extender, Flight, Fullgreen, Ideal Market, Kidney Wax, Lady Washington, Pink, Pinto, Ranger, Round Pod, Seminole, Stringless Green Refugee, Striped Hope, Tenderlong 15, Topcrop, U.S. No. 5 Refugee, Valentine, and Wade.
9. *Downy Mildew* — Serious on *lima bean* along the Atlantic seaboard where days are moderately warm, nights cool, and the humidity is high. Cottony mold patches on the pods, young shoots, flowers, and leaves. Affected parts turn black and shrivel. Shoots and flowers are distorted. *Control*: Plant certified, western-grown seed. Four-year rotation. Burn crop debris after harvest. Plant in well-drained soil. Normally resistant *lima bean* varieties: New Fordhook types U.S. 156, 242, etc., Henderson Bush types have some resistance, Thaxter, U.S. 155, 255, 355, 1556, and 1558. Spray at least weekly, with maneb, zineb, captan, or fixed copper. Copper sprays may cause some pod spotting.
10. *Seed Rots, Damping-off* — Seeds decay. Stand is thin and weak. Seedlings wilt and collapse from a rot at or below the soil line. Most serious in cool, wet weather. *Control*: Plant seed treated with thiram, chloranil, or captan plus dieldrin, lindane, or heptachlor (see Table 13 in the Appendix). Plant in warm, well-drained soil. After planting, treat as for Cabbage Wirestem.
11. *Ashy Stem Blight, Charcoal Rot* — Widespread. Mostly in southern states. Seedlings blacken and collapse. Slightly sunken, reddish-brown to black areas on stem at the soil line. The centers later turn ashy gray and become sprinkled with black dots. Disease spreads up the stem and down into the roots. Plants usually die before producing seed. Roots are decayed and blackened. *Control*: Plant certified, western-grown seed in well-drained soil. Treat seed as for Seed Rot (above). Keep down weeds. Keep plants growing vigorously by proper fertilization and watering in dry weather. Rotate, excluding beans, gourds, watermelon, sweetpotato, pepper, potato, dahlia, chrysanthemum, and related plants. Collect and burn crop debris.
12. *Lima Bean Pod Spot or Blight* — Atlantic seaboard. Small to large, irregular, brown patches on leaves. Pale brown to black watery spots may develop on the older pods. Affected areas may be sprinkled with minute black "pimples." *Control*: Plant certified, western-grown seed. Four-year rotation. Spray as for Downy Mildew (above).
13. *Curly-top* — Western states. Leaves become puckered, cup downward. Become brittle, stunted, and either a darker green or yellowish. Plants dwarfed and bunchy. Older plants ripen early, while younger plants die quickly or gradually. Pods reduced in size and number. See Figure 76. *Control*: Plant at the proper time for your area (check with your county agent or extension entomologist) to escape the spring migration of the beet leafhopper which transmits the Curly-top virus. Resistant bean varieties: Burtner's Blightless, California Pink, California Red, Columbia, Golden Gem, Great Northern, Idaho Bountiful, Jenkins, Pink and Red Mexican, Pinto, Pioneer, and Stringless Green Pod. Most *lima bean* varieties are fairly resistant.



Fig. 76. Curly-top of bean.

14. *Root-knot, Cyst Nematodes* — Mostly southern states. Plants stunted, yellowish, and sickly. Irregular, swollen galls which are *enlargements* of roots themselves. Cannot be rubbed off. *Control:* Rotate. Maintain vigor. Fertilize, water, keep down weeds. Where severe, fumigate soil in the fall with D-D, EDB, etc., following the manufacturer's directions. See (37) Root-knot under General Diseases. Resistant bean varieties: Alabama Pole No. 1 and 2, Spartan, and State. Resistant *lima beans*: Bixby, Hopi 155, 200, and 5989, Nemagreen, Nemagreen Bush, Westan, and certain Rico numbers. *Jackbean* and *swordbean* are also resistant.
15. *Other Fungus Leaf Spots, Pod and Stem Spots or Blotches, Stem Anthracnose, Lima Bean Scab* — Spots of various sizes, shapes, and colors on the leaves, stems, and pods. Spots on leaves may drop out leaving shot-holes. Leaves may wither and fall early. Plants may be yellowish, stunted and die early. Seeds shriveled. *Control:* Plant certified, western-grown seed in well-drained soil. Keep plants growing vigorously. Spray as for Downy Mildew (above). Two-year rotation or longer. Collect and burn crop debris after harvest. Resistant varieties (e.g., *lima bean* to Stem Anthracnose) may be available shortly. Refrigerate promptly after harvest.
16. *Baldhead, Snakehead* — Seedlings are stumps without growing tips. Plants die or remain stunted. *Control:* Plant certified, high-quality, crack-free seed in a well-prepared seedbed. Treat seed as for Seed Rots (above). Avoid deep planting.
17. *Sunscald, Leaf Scorch* — Pods exposed to the hot sun show reddish or pale brown spots and streaks. Irregular, dead, brown areas form on the leaves. *Control:* Plant in well-drained soil. Control other diseases and insects.
18. *Web Blight* — Southeastern states. Definite, round to irregular brown spots with a distinct, darker border on the leaves and pods. Spots are of variable size. Under moist conditions leaves are a scalded, light green color. Later the whole leaf turns gray to brown and dies. Other leaves and stems soon die. Stems are girdled by enlarging, tan to brown cankers. Diseased foliage may be held together (webbed) by delicate, whitish fungus hyphae. *Control:* Same as for Root Rots (above). Spray as for Downy Mildew (above).
19. *Fusarium Yellows, Wilts* — Western states. The lower leaves, especially on one side of the plant, gradually turn yellow. The disease progresses upwards with the older leaves turning yellow and dropping off. Plants may die. Stems show brown streaks when cut. *Control:* Plant disease-free seed in uninfested soil. *Lima beans* are highly resistant or immune. Otherwise same as for Root Rots (above).
20. *Verticillium Wilt* — See (15B) Verticillium Wilt under General Diseases.

21. *Spotted Wilt, Ringspot* — Plants may die outright or leaves die one by one. See (17) Spotted Wilt under General Diseases.
22. *2,4-D Injury* — See under Grape. Beans are very susceptible.
23. *Other Root-feeding Nematodes* (awl, dagger, lance, pin, reniform, ring, root-lesion or meadow, sheath, spear, spiral, sting, stubby-root, stunt or stylet) — Mostly southern states. Associated with sickly, stunted plants. *Control:* See under Root-knot (above).
24. *Chlorosis* — In alkaline or very acid soils where there is a "deficiency" of zinc, copper, magnesium, or manganese. *Control:* Have the soil tested and follow the recommendations.
25. *Crown Gall* — See (30) Crown Gall under General Diseases.

BEANTREE — See **Goldenchain**

BEARBERRY — See **Blueberry**

BEARD-TONGUE — See **Snapdragon**

BEAUTYBERRY — See **Lantana**

BEAUTY-BUSH — See **Viburnum**

BEDSTRAW — See **Buttonbush**

BEEBALM — See **Salvia**

BEECH [AMERICAN or SILVER, EUROPEAN, FERNLEAF, JAPANESE, ORIENTAL, PURPLE, PURPLE WEEPING, PYRAMIDAL, SIEBOLD'S, WEEPING] (*Fagus*)

1. *Wood, Heart, and Butt Rots* — Cosmopolitan. See under Birch, and (23) Wood Rot under General Diseases.
2. *Twig and Branch Cankers, Dieback* — Widespread. May be serious. See under Maple. Control scale insects using DDT and malathion. Or apply a dormant lime-sulfur spray (1 to 20 dilution).
3. *Bleeding Canker* — Northeastern states. Light brown to reddish-brown liquid ("blood") oozes from bark usually near the base. See also under Maple. *Control:* Cut down and burn severely infected trees. Avoid wounding bark and overfeeding. But keep trees vigorous by fertilization and watering during droughts. Injection of trees with "Carosel," which contains a mixture of helione orange and malachite green dyes, has helped check the disease. There is no cure.
4. *Powdery Mildew* — Powdery, grayish-white mold on leaves and young shoots. Leaves may turn yellow and wither. *Control:* If severe enough, spray twice, 10 days apart, using sulfur or Karathane.
5. *Root Rot* — See under Apple, and (34) Root Rot under General Diseases. May be associated with nematodes (e.g., root-knot, spiral).
6. *Leaf Scorch* — Leaves turn brown at margins. Scorching may progress until leaves fall. Often follows hot, dry, windy weather. *Control:* Fertilize trees. Water in hot, dry weather. Prune to open up trees.
7. *Leaf Spots* — Minor problem. See under Maple.
8. *Mottle Leaf* — Northeastern states. Cause unknown, possibly a virus. Unfolding leaves are sprinkled with small, semitransparent spots with a yellowish-green or white halo. Spots enlarge, turn brown, and dry. Most common between the veins and along the leaf margins. Brown areas increase in size until the entire leaf is

scorched. Leaves may drop early. A new set of normal leaves may form in mid-summer. The bark on the trunk and large branches may be scalded and die in patches. *Control:* Fertilize trees to maintain vigor. Protect bark from summer sun by wrapping with burlap or sisalkraft paper.

9. *Mistletoe* — See (39) Mistletoe under General Diseases.
10. *Sooty Mold* — Black moldy patches on foliage. See under Elm.
11. *Felt Fungus* — Southern states. See under Hackberry.

**BEET [GARDEN, SUGAR], SWISS CHARD, LEAF or SPINACH BEET,
MANGEL, MANGOLD (*Beta*); SPINACH (*Spinacea*); BURNING-BUSH,
SUMMER-CYPRESS (*Kochia*); NEW ZEALAND SPINACH (*Tetragonia*)**

1. *Cercospora Leaf Spot* — General. Small spots with gray to brown centers and reddish-purple margins develop on leaves, leaf stems, flower parts, and even



Fig. 77. Cercospora leaf spot of beet.

seeds. Spots may drop out leaving ragged leaves which often wither and die. *Table beets* are somewhat resistant. See Figure 77. *Spinach* is seldom seriously injured. *Sugar beet* varieties differ in resistance. Often most severe when plants are also infected with Virus Yellows (below). *Control:* Three-year rotation. Burn tops or plow under cleanly after harvest. Plant disease-free seed or treat as for Seed Rot (below). Keep plants growing vigorously by fertilizing and watering during dry periods. Space plants. Apply maneb, zineb, or fixed copper at 2-week intervals in rainy seasons.

2. *Seed Rot, Black Root Rot, Damping-off* — General. Seeds rot. Poor stand. Seedlings and older plants wilt and collapse or survive and produce sickly, yellowish, stunted plants. *Control:* Rotate. Plant in well-drained soil. Treat seed with thiram, captan, or dichlone (Table 13 in the Appendix). If damping-off starts, water with captan (1½ tablespoons per gallon; use 1 pint per square foot).
3. *Curly-top* — Common and serious in the western half of the United States. Younger

leaves curl upward. May later turn yellow. Plants become stunted or dwarfed with thickened, rolled, dull green, crimped, or brittle leaves. Roots are "hairy" or "woolly." Black rings appear when beet is cut across. Young plants may turn yellow and die. *Control:* Plant as early as practical or at the time recommended for your area. Keep down weeds. Varieties differ in resistance. See also under Bean, and (19) Curly-top under General Diseases.

4. *Spinach Fusarium Yellows, Wilt* — General. Young plants stunted, or may wilt and die. Leaves pale, turn yellow, wilt, and die slowly starting with the oldest leaves. Brown streaks inside root. Roots decay. *Control:* Long rotation. Harvest early. Destroy plant debris after harvest. If practical, plant in clean or sterilized soil. See "Soil Treatment Methods and Materials" in the Appendix. Resistant varieties of *spinach* offer the best hope (e.g., strains of Virginia Savoy and Domino).
5. *Blackleg, Crown or Heart Rot, Dry Rot* — Dark brown to black cankers at soil line or on taproot. Lower leaves turn yellow, then brown, and fall early. Seedlings may darken and collapse. *Control:* Plant disease-free seed in warm, well-drained soil in a well-prepared seedbed. Avoid overcrowding, excessive soil acidity, and too deep planting of seed. Soil should be adequately supplied with boron. Keep plants growing vigorously.
6. *Blackheart* (primarily beet) — General. Locally severe where the phosphorus supply in the soil is low. Plants often slightly stunted. Leaves dark green with dark brown areas between the veins. Leaf edges may be shriveled; *spinach* leaves may be small and curled. Taproot is internally discolored. *Control:* Have the soil tested. Apply the recommended amount of superphosphate-containing fertilizer.
7. *Heart Rot, Boron Deficiency, Cracked Stem* — Locally severe where boron is lacking in the soil. Middle and older leaves are abnormally crinkled. If severe, young leaves are stunted, twisted, narrow, and redder or blacker (pale green or yellow in *spinach*) in color than normal. These leaves may wilt and die in midsummer. Gray, brown to black, internal or external dry rot of the taproot. See Figure 1. *Control:* Have the soil tested. Apply borax as recommended. Resistant *beet* varieties: Detroit Dark Red and Long Blood.
8. *Crown Gall* — Occasional. Swollen, gall-like growths near the soil line. See (30) Crown Gall under General Diseases.
9. *Mosaics, Savoy, Yellow Net, Yellow Vein, Ringspot* — Widespread. Leaves mottled; light and dark green or yellow. Leaf surface often crinkled and curled (or savoyed). May show faint zigzag lines, rings, and other patterns. Leaves die back from the tips. Growth is often stunted. Center leaves are often mottled, stunted, and distorted. Beet roots are smaller than normal. May be "hairy." *Control:* Plant virus-free seed from healthy mother plants. Keep down weeds. Destroy the first infected plants. Maintain balanced soil fertility. Control aphids and plant bugs, which transmit the viruses, by applying malathion weekly.
10. *Virus or Beet Yellows, Spinach Blight* (beet, Swiss chard, mangel, mangold, *spinach*, New Zealand *spinach*, summer-cypress) — Symptoms variable depending on the plant, virus strain, and other factors. Plants often dwarfed and yellowed. The veins in young leaves are usually conspicuously yellow (cleared). Outer and middle leaves gradually become yellow, thickened, and brittle. Yellowing usually starts at the upper margins and tips. Table beet leaves are usually deep red with little yellowing. Leaves may later turn brown and die prematurely, starting at the tips. Root may be small. Yellows-infected plants may be more susceptible to Leaf Spot and other diseases. *Control:* Plant late or early to avoid the summer migration of aphids which transmit the viruses. Use virus-free seed. Keep down weeds and wild beets in and

around the garden. Many weeds are symptomless carriers. Spray in the spring to control aphids using malathion. Plant normally resistant *spinach* varieties: Blight Resistant Virginia Savoy, Dixie Market, Domino, Early Hybrid No. 7, Old Dominion, and Virginia Blight Resistant. Check the adaptability of spinach varieties with your county agent or extension horticulturist. *Beet* varieties also differ in resistance.

11. *Downy Mildew, Blue Mold* — General during cool, humid seasons. Young leaves are covered with a violet- or yellowish-gray mold. Older leaves have small to large, irregular, pale green or yellow areas on the upper leaf surface with the mold growth on the underside. Leaves may become thickened and curled, dry up, darken, or rot. Similar spots occur on the seed stalks which may be stunted or killed. Serious in cool, wet weather. Damaging to spinach and Swiss chard in the seedbed. See Figure 20D under General Diseases. *Control:* Three-year rotation. Avoid overcrowding. Keep down weeds. Plant disease-free seed in well-drained, fertile soil. Destroy old crop debris. Spray when disease is first seen, using zineb, maneb, chloranil, or a copper-containing fungicide. Repeat at 5- to 10-day intervals. Soak *spinach* seed in hot water (122° F.) for 25 minutes. Dry, then dust with thiram, chloranil, dichlone, captan, or Semesan. Resistant *spinach* varieties: Badger Savoy, Califlax, Dixie Market, Early Hybrid No. 7, Savoy Supreme, Viking, and Wisconsin Bloomsdale. Resistant *beet*: F.M. Detroit Dark Red.
12. *Scab* — Widespread. Raised, rough, scablike areas or warts on the root. See under Potato. Worst in lime-rich soils. *Control:* Do not grow in soil which has produced scabby potatoes. Keep soil acid. Varieties differ in resistance.
13. *Root Gall, Root-knot, Cyst Nematodes* — See under Bean, and (37) Root-knot under General Diseases. *Control:* If serious enough, fumigate soil with D-D or Telone before planting.
14. *Watery Soft Rot, Drop, Stem Rot, Wilt, Storage Rots* — See under Carrot.
15. *Rusts* — Western half of the United States. Small, yellow to bright orange, reddish-brown, or dark brown pustules, mostly on underside of leaves. Leaves may wither. One rust is serious only near the alternate hosts — salt and needle grasses (*Distichlis* and *Aristida*). *Control:* Spray as for Cercospora Leaf Spot and Downy Mildew (both above) or use dichlone. Destroy nearby salt and needle grasses by burning in the fall or plowing under deeply. Destroy tops after harvest.
16. *Root Rots, Crown Rots, Southern Blight* — General. See under Bean, and (34) Root Rot under General Diseases. *Beet* varieties in the future may have resistance.
17. *White-rust* — Southern states. Small, white, powdery pustules mostly on underleaf surface. If severe, leaves or entire plants may wither and die. See Figure 23C under General Diseases. *Control:* Three-year rotation. Plant disease-free seed. Spraying as for Downy Mildew and Leaf Spot (above) may be beneficial. Destroy infected plants and debris after harvest.
18. *Minor Leaf Spots, Anthracnose* — General. Small, round to irregular, variously colored leaf spots. Spots often enlarge and run together. Leaves may wither and die. Mold growth may develop on affected parts in damp weather. *Control:* Same as for Cercospora Leaf Spot (above).
19. *Web Blight* — Southeastern states. See under Bean.
20. *Gray-mold Blight* — See (5) Botrytis Blight under General Diseases.
21. *Black Streak, Bacterial Spot (beet)* — Western states. Irregular, dark brown to black, spots on leaves and streaks on the leaf stalks, midrib, and larger leaf veins. Affected leaves may bend over sharply, become limp, and later wither. *Control:* Plant disease-free seed in soil which has not grown beets or related crops for at least 3 years. Collect and burn or bury plant debris after harvest. Avoid overfertilizing with nitrogen.

22. *Bacterial Soft Rot* — General. See (29) Bacterial Soft Rot under General Diseases. *Control:* Same as for Black Streak (above).
23. *Bacterial Pocket, Beet Gall* (garden and sugar beets) — Deeply indented, tumor-like growths on crown of roots. Galls have irregular brown areas inside. Galls soon disintegrate. *Control:* Same as for Black Streak (above). Avoid cultivating injuries.
24. *Bacterial Wilt* — See (15C) Bacterial Wilt under General Diseases.
25. *White or Leaf Smut* (spinach) — Indistinct white spots on the lower leaf surface. When severe, leaves may whiten. *Control:* Not usually necessary. Same as for Cercospora Leaf Spot and Downy Mildew (both above).
26. *Spinach Yellow Dwarf* — Young leaves may be mottled light and dark green, curled, and puckered. Older leaves develop yellow blotches. Heart leaves are stunted. May turn yellow and die. *Control:* Do not grow spring spinach near winter spinach. Destroy wild spinach plants. With malathion control aphids which transmit the virus.
27. *Spotted Wilt, Ringspot* — Zigzag lines or other irregular markings on the leaves. See (17) Spotted Wilt under General Diseases.
28. *Chlorosis* — Leaves turn yellowish-green or yellow, first at the margins, later between the veins. Leaves may later wither and die. This disease is due to a deficiency of iron or manganese in alkaline soils. *Control:* Acidify soil or spray plants with iron sulfate or manganese sulfate or both, 1 ounce in 2½ gallons of water. Plants should recover in 1 to 2 weeks. Repeat as necessary.
29. *Other Root-feeding Nematodes* (e.g., lance, nacobus, pin, reniform, meadow or root-lesion, rot, sheath, spear, spiral, sting, stubby-root, stylet or stunt) — Associated with stunted, sickly plants. Roots short, stubby, discolored, and die back. Nematodes make wounds for root-rotting fungi. *Control:* Same as for Root Gall (above).
30. *Verticillium Wilt* (beet, spinach) — See (15B) Verticillium Wilt under General Diseases.
31. *Powdery Mildew* (beet) — See (7) Powdery Mildew under General Diseases.

BEGONIA [FIBROUS ROOTED, HARDY, HYBRID, REX or FOLIAGE, RHIZOMATOUS, TUBEROUS ROOTED, WAX or EVERLASTING] (Begonia)

1. *Gray-mold Blight, Botrytis Blight, Blotch* — Cosmopolitan and serious. Large, blotchy, dead areas on leaves, stems, cuttings, and flowers. A coarse gray mold grows on affected parts in wet weather. Leaves and flowers turn brownish-black and die. Common in greenhouses. *Control:* Destroy severely affected plants or plant parts when first found. Space plants. Improve air circulation. Keep water off the foliage. Keep down weeds. Avoid a wet mulch and overwatering. Plant in sterilized soil (pages 437-44). Keep plants growing at a steady rate. Indoors use sufficient light. Apply captan, maneb, or zineb to plants and soil.
2. *Crown, Stem and Root Rots, Cutting Rot, Damping-off* — Cosmopolitan. Plants pale. Cause poor growth. Stems and crowns often water-soaked and darkened near the soil line. Often collapse. Lower leaves may be water-soaked and flabby. Roots discolored and decayed. Seedlings and cuttings rot. Tubers may also rot. May be associated with root-feeding nematodes (e.g., root-lesion or meadow, spiral). *Control:* Same as for Gray-mold Blight (above). Use seed and leaves from disease-free plants.
3. *Bacterial Leaf Spot, Bacteriosis* — Widespread, especially on tuberous begonias. Small, round, water-soaked spots which later turn yellow or brown. Spots enlarge and run together. Leaves may wither and fall early. Main stem may rot, killing

plant. See Figure 16B under General Diseases. *Control:* Same as for Gray-mold Blight (above) except use streptomycin when necessary. Propagate with cuttings from disease-free plants. Varieties differ in resistance. Indoors reduce the temperature and humidity. Keep water off the foliage. Space plants.

4. *Crown Gall* — More or less round galls develop on the stem near the soil line. Galls may later rot, killing the plant. *Control:* Take tip cuttings and then destroy the mother plant. Pot in sterilized soil (see pages 437-44). Avoid wounding stems. Space plants for good air movement.
5. *Root-knot* — See (37) Root-knot under General Diseases. Plants stunted and sickly. On tuberous begonias the root galls become quite large.
6. *Powdery Mildews* — Common. May be serious on tuberous begonias. White blotches on leaves. Leaves often deformed. *Control:* Apply Karathane or phaltan, plus a spreader-sticker, when mildew is first seen. Repeat as necessary. Acti-dione has also proven effective.
7. *Leaf Nematode Blight* — Widespread and serious. Small to large, irregular, brown patches on leaves between the veins. Leaves curl up and drop off. Plants often stunted and unsightly. See (20) Leaf Nematode under General Diseases. *Control:* Keep water off the foliage. Space plants. Propagate only from disease-free plants. Plant in sterilized soil. Where necessary, dip or spray plants weekly with malathion. Remove and burn all infested plant parts. Begonias in small pots may be disinfested by dipping in hot water (1 minute at 120° to 121° F.; 3 minutes at 117° to 119° F.; or 5 minutes at 115° F.).
8. *Spotted Wilt* — Zoned, yellowish to brown, or ringlike spots on leaves. Plants stunted and bronzed in color. *Control:* Destroy infected plants. By using DDT control thrips which transmit the virus.
9. *Aster Yellows* — Plants stunted, bushy, and yellow in color. *Control:* Same as for Spotted Wilt, except virus is spread by leafhoppers.
10. *Corky Scab, Oedema* — Indoor plants show small, water-soaked spots which later become light brown, corky growths. Found on underside of leaves and along stems. *Control:* Avoid overwatering or sprinkling plants. Keep down humidity in cool, cloudy weather.
11. *Leaf Spots, Anthracnose* — Spots of various sizes, shapes, and colors on leaves. *Control:* Same as for Gray-mold Blight (above).
12. *Mosaic* — Uncommon. Yellowish areas and sometimes brown spots, between the leaf veins. *Control:* Destroy affected plants. Spray or fumigate to control aphids and other insects. Use DDT or methoxychlor and malathion.
13. *Verticillium Wilt* — See (15B) Verticillium Wilt under General Diseases.

BELAMCANDA — See Iris

BELLADONNA LILY — See Chrysanthemum

BELLFLOWER [AMERICAN, CHIMNEY, TUSSOCK, WILLOW or PEACH BILLS], BLUEBELLS-OF-SCOTAND, CANTERBURY-BELLS, HAREBELL (*Campanula*); BALLOONFLOWER, CHINESE BELLFLOWER (*Platycodon*); VENUS-LOOKINGGLASS (*Specularia*)

1. *Leaf Spots* — Small to large, round to irregular, yellowish, brown, or grayish spots on leaves. *Control:* Destroy tops in the fall. Apply zineb, captan, or a copper-containing fungicide, several times, 10 days apart.
2. *Stem Rot, Crown Rot, Southern Blight, Root Rots* — Grayish-white, cottony, or

brown areas on stem which later enlarge. Stem rots, causing plant to wilt and collapse. *Control:* Dig up and burn infected plants and surrounding soil. Four-to 6-year rotation. Plant in clean or sterilized soil. See "Soil Treatment Methods and Materials" in the Appendix.

3. *Rusts* (bellflower, venus-lookingglass) — Widespread. Yellow, orange, reddish-brown or black, powdery pustules on underside of leaves. Plants stunted. Usually serious if certain infected pines (alternate host of one rust) are growing nearby. *Control:* Avoid growing near pines (*Pinus rigida* and *P. resinosa*), or apply zinceb, ferbam, or maneb, three times, 10 days apart, starting when rust is first seen.
4. *Root-knot* — See (37) Root-knot under General Diseases.
5. *Powdery Mildew* (bellflower, Canterbury-bells) — See (7) Powdery Mildew under General Diseases.
6. *Spotted Wilt* (Canterbury-bells) — Plants stunted. Growth is poor. Leaves show pale ringspots or wavy line markings. *Control:* Destroy infected plants. Control thrips which transmit the virus. Use DDT or malathion.
7. *Aster Yellows* (Canterbury-bells) — See (18) Yellows under General Diseases.
8. *Gray-mold Blight, Crown Rot* — See under Begonia, and (5) Botrytis Blight under General Diseases.
9. *Verticillium Wilt* — Lower leaves turn yellow, wilt, and die. Wilt gradually progresses up the plant. *Control:* Destroy infected plants. Rotate. Plant in well-drained soil.
10. *Mosaic* — See under African-violet, and (16) Mosaic under General Diseases.
11. *Seed Smut* (venus-lookingglass) — Seeds filled with dark, powdery masses. *Control:* Plant disease-free seed.
12. *Leaf and Stem Nematode* (bellflower) — See (20) Leaf Nematode under General Diseases.

BELLIS — See Chrysanthemum

BELLS OF IRELAND — See Salvia

BELLWORT — See Lily

BELOPERONE — See Clockvine

BENINCASA — See Cucumber

BENT, BENTGRASS — See Lawnglass

BENZOIN — See Avocado

BERBERIS — See Barberry

BERMUDAGRASS — See Lawnglass

BETONY — See Salvia

BIDENS — See Chrysanthemum

**BIGNONIA, TRUMPETFLOWER, CROSSVINE, CHINESE TRUMPETCREEPER
(*Bignonia*)**

1. *Leaf Spots, Spot Anthracnose* — Leaves variously spotted. *Control:* See under Chrysanthemum.

2. *Sooty Mold, Black Mildews* — Southern states. Black, moldy patches on foliage. See (12) Sooty Mold under General Diseases.
3. *Gray-mold Blight* — Southern states. See (5) Botrytis Blight under General Diseases.
4. *Root-knot* — See (37) Root-knot under General Diseases.
5. *Dieback, Canker* — See under Apple.

BINDWEED — See Morning-glory

BIRCH [BLACK, CUTLEAF, DWARF, EUROPEAN, GRAY or POPLAR, MONARCH, PAPER or CANOE, PYRAMIDAL, RIVER or RED, SWAMP or HAIRY DWARF, SWEET or CHERRY, WATER, WEEPING, WESTERN PAPER, WHITE, YELLOW] (*Betula*); ALDER [AMERICAN, BLACK, CUTLEAF BLACK, EUROPEAN GREEN, GREEN, HAZEL or SMOOTH, ITALIAN, SPECKLED or HOARY-LEAVED, JAPANESE, MANCHURIAN, NEW MEXICAN, SEASIDE, SIERRA, SITKA, SPECKLED, THINLEAF, WEEPING] (*Alnus*); HORNBEAM [AMERICAN, EUROPEAN, HEARTLEAF, YEDDO] (*Carpinus*); HAZELNUT [AMERICAN, BEAKED or CUCKOLD, CALIFORNIA, CHINESE, EUROPEAN, JAPANESE, TIBETIAN, TURKISH], FILBERT, PURPLE-LEAVED FILBERT (*Corylus*); IRONWOOD, HOPHORNBEAM [AMERICAN, EASTERN, EUROPEAN, JAPANESE] (*Ostrya*)

1. *Wood Rots, Heart Rots, Butt Rots* — Cosmopolitan. Wood may be lightweight, soft, and punky. Hoof- or shelf-shaped fruiting bodies (conks) develop along dead or dying trunk and branches. Diseased wood may be discolored or stained. See Figure 39 under General Diseases. *Control:* Maintain good tree vigor by fertilizing and watering during dry periods. Control other diseases and insects. Avoid wounding the bark. Paint over all wounds promptly with a good tree wound dressing.
2. *Dieback, Twig, Branch and Trunk Cankers* — Upper branches progressively die back. Irregular, swollen cankers may develop on twigs, branches and trunk. Infected trunk and branches may be flattened and bent. Plant parts die when cankers girdle. Often associated with borers, drought, and other diseases. *Control:* Destroy trees with severe trunk cankers. Prune out and burn young cankers and all dead wood. Make clean, flush cuts. Sterilize tools between cuts. Otherwise same as for Wood Rots.
3. *Leaf Spots, Anthracnose* — Widespread. Round to irregular, brownish, yellowish or gray spots, following cool, wet, spring weather. If spots are numerous, leaves may drop early. *Control:* Seldom necessary. Collect and burn fallen leaves. If practical, spray as for Leaf Rust (below) or use captan.
4. *Leaf Rust* — Numerous, small, bright reddish-yellow, later dark brown to nearly black, powdery pustules on the lower surface of leaves. Leaves may drop early. Seldom serious. *Control:* Do not plant near larch, the alternate host of this rust. If practical, apply zineb, maneb, or dichlone as the buds burst open. Repeat 10 and 20 days later.
5. *Leaf Blisters or Curls, Witches'-broom* — Yellow or red blisters may cause the leaves to be swollen, distorted, curl, and drop early. Hypertrophy of mature fertile catkins on alders. Clusters of weak twigs (witches'-brooms) may arise near the same spot on the twigs. See (10) Leaf Curl under General Diseases. *Control:* Prune out witches'-brooms. Collect and burn fallen leaves. If practical, apply ferbam or a copper-containing fungicide, plus spreader-sticker, once before the buds swell in early spring.

6. *Powdery Mildews* — Widespread. Powdery, grayish-white mold patches on the leaves, young twigs, and female catkins of alders. Severely infected leaves may turn yellow, wither, and drop early. *Control:* If severe and where practical: Apply sulfur or Karathane one or two times, 10 days apart, starting when mildew is first seen.
7. *Bacterial Blight, Bacteriosis* (hazelnut, filbert) — Serious on the Pacific Coast. Brown to black, round to angular spots on the buds, leaves, and young shoots (up to 4 years old) in the spring. Cankers develop on young tree trunks. Often kills young trees. Maturing nuts are discolored. *Control:* See under Walnut. Resistant filberts: Daviana, Bolwyller, and Graham. Apply bordeaux mixture (3-1½-50) in August before fall rains. Repeat when ¾ of leaves have dropped. Sterilize pruning tools with mercuric chloride or 70 per cent denatured alcohol.
8. *Slime Flux, Wetwood* — See under Elm.
9. *Root Rots* — Trees decline in vigor. Foliage is thin and sickly. Leaves may turn yellow, wither, and drop early. See under Apple, and (34) Root Rot under General Diseases.
10. *Sooty Mold* — See (12) Sooty Mold under General Diseases.
11. *Crown Gall* — See under Apple, and (30) Crown Gall under General Diseases.
12. *Kernel Bitter Rot, Brown Stain* (hazelnut) — Problem on the Pacific Coast. Check with local authorities (see above).
13. *Root-knot* — See under Peach, and (37) Root-knot under General Diseases.
14. *Twig Blights, Dieback, Bark Canker* — Widespread. Discolored cankers girdle the stems causing the foliage and stems beyond to wither and die. *Control:* Prune out and burn dead and cankered wood. Spraying as for Leaf Rust (above) may be beneficial.
15. *Bleeding Canker* — Northeastern states. See under Beech and Maple.
16. *Felt Fungus* (hornbeam) — Southern states. Smooth, buff-colored growth on the bark. See under Hackberry.
17. *Mistletoe* — See (39) Mistletoe under General Diseases.

BIRD-OF-PARADISE-FLOWER (*Strelitzia*)

1. *Root and Seed Rot* — See (34) Root Rot under General Diseases. May be associated with root-feeding nematodes (e.g., burrowing, root-lesion, stubby-root). *Control:* Plant disease-free seed or soak seed for a day in water (at room temperature) then in hot water (135° F.) for 30 minutes. Cool, dry, and plant in clean or sterilized soil.

BIRTHWORT — See *Aristolochia*

BISHOPSCAP — See *Hydrangea*

BITTERSWEET [CLIMBING, ORIENTAL or CHINESE] (*Celastrus*); ARABIAN-TEA (*Catha*); EUONYMUS [BROADLEAF, BROOK or STAWBERRY-BUSH, CLIMBING, EVERGREEN or EVERGREEN BURNING-BUSH, JAPANESE EVERGREEN, WINTERBERRY, YEDDO], SPINDLE-TREE [ALDENHAM, EUROPEAN, WINGED or WINGED BURNING-BUSH], BURNING-BUSH or WAHOO, and WINTERCREEPER [BIGLEAF, GLOSSY, SILVER-EDGE] (*Euonymus*); CLIFFGREEN, MYRTLE BOXLEAF (*Pachistima*)

1. *Powdery Mildews* — Widespread. May be serious. White, powdery mold patches on the leaves. Leaves may turn yellow and drop early. *Control:* Remove badly attacked shoots. Prune to thin out shrubs. Where practical, apply sulfur, Karathane,

or Acti-dione several times, 10 days apart. Avoid applications when the temperature is above 85° F.

2. *Crown Gall* — Common. Large, irregular galls appear on both the roots and stems. *Euonymus* may be severely infected. See (30) *Crown Gall* under General Diseases.
3. *Leaf Spots, Anthracnoses, Leaf Scab* — Variously sized and colored spots on the leaves. Common following wet weather. *Control:* Collect and burn fallen leaves. Prune to thin out shrubs. Apply zineb, maneb, or fixed copper several times, 7 to 10 days apart. Start as the leaves are unfolding.
4. *Stem Cankers, Dieback* — See under *Maple*. Same as for *Leaf Spots* (above). Cut out and burn dead and dying twigs.
5. *Root-knot* — See (37) *Root-knot* under General Diseases.
6. *Other Root-feeding Nematodes* (e.g., dagger, needle, pin, ring, root-lesion, spiral, stylet) — Associated with sickly stunted plants. *Control:* Same as for *Root-knot* (above).
7. *Euonymus Mosaic, Infectious Variegation* — Yellowing develops along the leaf veins. *Control:* Do not use variegated plants for propagating. If serious enough, destroy infected plants.
8. *Thread Blight* (*euonymus*) — Southeastern states. See under *Walnut*.

BLACK-ALDER — See Holly

BLACKBERRY — See Raspberry

BLACKBERRY-LILY — See Iris

BLACK COHOSH — See Anemone

BLACK-EYED-SUSAN — See Chrysanthemum

BLACK GUM — See Dogwood

BLACKHAW — See Viburnum

BLACK-SALSIFY — See Lettuce

BLACK SAMPSON — See Chrysanthemum

BLACK-SNAKEROOT — See Anemone

BLACKTHORN — See Peach

BLACK WALNUT — See Walnut

BLADDERNUT — See American Bladdernut

BLADDER-SENNNA — See Honeylocust

BLAZING-STAR — See Chrysanthemum

BLECHNUM — See Ferns

**BLEEDINGHEART, DUTCHMANS-BREECHES, SQUIRRELCORN (*Dicentra*);
CORYDALIS**

1. *Rusts* (*Dutchmans-breeches, corydalis*) — Yellowish-orange spots on the upper leaf surface with clusters of slender, cuplike structures developing on the lower surface. Alternate hosts include wood-nettle and wild grasses. *Control:* Destroy nearby alternate hosts. If practical, apply zineb, maneb, or ferbam several times, 10 days apart, starting when rust is first seen.
2. *Crown Rot, Stem Rots, Wilt* — See (21) *Crown Rot* under General Diseases.

3. *Fusarium Wilt* (bleedingheart) — See (15A) *Fusarium Wilt* under General Diseases.
4. *Downy Mildew* — May be serious on plants growing in shade. See (6) *Downy Mildew* under General Diseases.
5. *Leaf Spot* — Small spots on leaves. *Control:* Spray or dust as for Rusts (above).

BLESSEDTHISTLE — See Chrysanthemum

BLOODROOT — See Poppy

BLUEBEARD — See Lantana

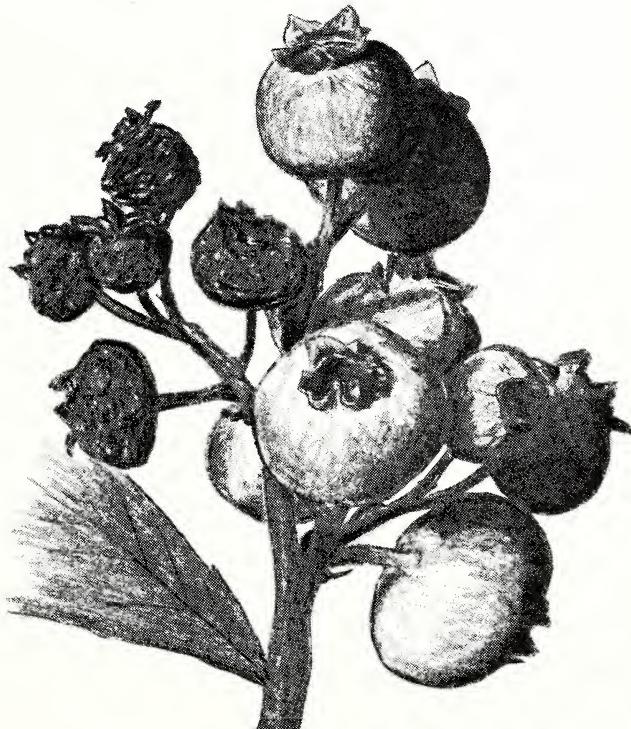
BLUEBELL OF ENGLAND — See Tulip

BLUEBELLS — See Mertensia

BLUEBERRY [BOX, CLUSTER, DRYLAND, GROUND, Highbush (BLACK, NORTHERN, SOUTHERN or SWAMP), LOWBUSH (RABBITEYE, SUGAR, UPLAND, MOUNTAIN CRANBERRY or LINGONBERRY)] (*Vaccinium*); STRAWBERRY-TREE, MADRONE (*Arbutus*); MANZANITA, BEARBERRY (*Arctostaphylos*); CASSANDRA or LEATHERLEAF (*Chamaedaphne*); CASSIOPE; HUCKLEBERRY [BLACK, BOX, GARDEN, DANGLEBERRY] (*Gaylussacia*); BOG LAUREL, MOUNTAIN-LAUREL, PALE LAUREL, SHEEP-LAUREL or LAMBKILL (*Kalmia*); KALMIOPSIS; FETTERBUSH, MALEBERRY, STAGGERBUSH (*Lyonia*); RUSTYLEAF, MINNIE-BUSH (*Menziesia*)

1. *Mummy Berry, Brown Rot, Blossom Blight, Twig Blight* (blueberry, mountain-laurel) — General eastern half of United States. Tips of new shoots wilt and turn

Fig. 78. Mummy berry of blueberry. The 5 dark berries to the upper left are "mummy berries." The rest of the fruit is healthy.



brown. Blossoms blasted. Nearly full grown blueberry fruit turn gray or tan, then shrivel into hard mummies. See Figure 78. *Control:* Avoid crowding and over-fertilizing plants. Resistant *blueberry* varieties: Cabot, Stanley, and Weymouth. Apply captan, zineb, ziram, ferbam, or dichlone several times, 7 to 10 days apart, starting when the buds unfold. Practice very clean cultivation in the spring through bloom.

2. *Botrytis Blight, Gray-mold Blight* — General. Blossoms blasted. Young blueberry fruit shrivel and turn a dull bluish-purple. They soon fall. There are irregular, brown leaf blotches. Tips of shoots die back. A gray mold may grow on affected parts. *Control:* Spray as for Mummy Berry (above). Avoid spring applications of fertilizer high in nitrogen. Prune shrubs annually.
3. *Red Leaf Gall, Swamp Cheese, "Rose Bloom," Shoot Hypertrophy* — General. Gall-like growths on twigs. Small, red blisters on leaves. Blossoms and small fruit swell abnormally. Affected parts turn pink to bright red in summer before falling off. *Control:* Plant disease-free stock. Prune and burn infected parts when first seen. If necessary, apply a single dormant spray *before* the buds swell, using copper, ferbam, or zineb.
4. *Powdery Mildew* — General on blueberry. Compact whitish mold on upper surface of leaves of certain susceptible varieties (Adams, Concord, Jersey, and Rubel). Etched, water-soaked spots appear on the lower surface of young leaves. Spots enlarge and the leaves of susceptible varieties (e.g., Pioneer, Cabot, Wareham) gradually turn yellow and may drop early. Mildew usually occurs after harvest and causes little damage. *Control:* Grow resistant *blueberry* varieties: Harding, Rancocas, Stanley and Weymouth. Apply Karathane twice, 10 days apart.
5. *Crown Gall* — Sometimes called Cane Gall. Swollen, rough, irregular, light brown to black galls along stems and small twigs. Sometimes at base of stems. Galls may girdle and kill stems. *Control:* Destroy severely infected plants. Use disease-free plants. When only slight infection is found, make pruning cuts several inches below any sign of infection. Disinfect before each cut by dipping shears in a 1:1,000 solution of mercuric chloride (see page 85 for precautions).
6. *Witches'-broom* — Short, swollen twigs crowded together giving a bushy or broom-like appearance. No fruit produced. Found near firs, the alternate host of the rust fungus. Witches'-broom of mountain-laurel is not caused by a rust. *Control:* Prune out and burn infected branches. Spraying as for Mummy Berry and Gray-mold Blight (both above) is probably beneficial. Destroy nearby, worthless true firs and infected blueberry plants since the rust fungus is perennial and systemic.
7. *Leaf Rust* — Widespread. Small, irregular, reddish-brown or black spots and yellowish pustules on the leaves. Leaves may wither and drop early. Severe only in certain years near hemlocks or spruces, the alternate hosts of the rust fungus. *Control:* If practical, spray as for Mummy Berry and Gray-mold Blight (both above). Grow resistant blueberry varieties.
8. *Blueberry Stunt* — Symptoms vary with time of year, stage of growth, and variety. The tip leaves on young shoots in the spring are first pale yellow at the margins and tip. Later the leaves turn completely yellow except for the leaf veins. These leaves become round, dwarfed, and cupped. Leaves on old canes turn prematurely red in early fall. The brilliant red color occurs in two lengthwise bands on the leaf. Plants are stunted and bushy with numerous, dwarfed side twigs. Affected plants are unproductive with small, bitter fruit. Leafhoppers transmit the virus. *Control:* Use only certified, virus-free nursery stock. Promptly dig up and destroy infected bushes, including the roots, when first found. Destroy wild blueberry plants in the area. Follow the spray program in the Appendix. Rancocas and Harding are highly resistant varieties.

9. *Blueberry Mosaic* — Leaves on one or more canes are brilliantly mottled with yellow, yellow-green, and red areas. The lower leaves on a cane generally show more color. Fruit production gradually declines. Mosaic is reported commonly on Stanley, Concord, and Dixi. *Control:* Same as for Stunt (above).
10. *Blueberry Shoestring* — Symptoms variable, even on the same plant. Brown to red bands develop along the midrib of a leaf and often extend partially into the lateral veins. Such leaves are wavy, distorted, and crescent-shaped. Severely affected leaves are narrow, pointed, strap-shaped, and light green to dull red in color. On certain varieties (e.g., Burlington, Cabot, and Jersey) red streaks, bands, or oval patches occur along the new canes and twigs. Cane growth is long and spindly. Such canes do not produce fruit. *Control:* Same as for Stunt (above).
11. *Blueberry Ringspots* — Eastern states. Leaves develop conspicuous, yellow to dead or red rings, spots, line, or jagged oakleaf patterns. Rings may drop out giving a tattered appearance. Rings may be evident on the stems throughout the year. The virus spreads rather rapidly in the field. Plants may be stunted and unproductive. Twigs die back. *Control:* Same as for Stunt (above).
12. *Twig Blight, Cane Cankers* — Often follows winter injury, sunscald, excessive soil moisture, insect attack, and other factors. Infected shoots wilt, wither, and die due to discolored, girdling cankers on the twigs and branches. *Control:* Remove and burn weak, unthrifty plants. Prune and burn blighted twigs in the winter. Make clean cuts 6 to 8 inches behind any sign of infection. Spray as for Mummy Berry and Botrytis Blight (both above). Increase vigor by fertilizing and watering during summer droughts. Plant disease-free stock of resistant varieties, if available. Check with your local nurseryman or extension plant pathologist.
13. *Chlorosis* — General in neutral and alkaline soils where these plants are not adapted. Leaves turn yellow except for the veins. See Figure 79. Plants are stunted, may die. *Control:* See under Rhododendron.
14. *Wood Rots, Trunk Canker* — General. See under Birch, and (23) Wood Rot under General Diseases.
15. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases.
16. *Mistletoe (manzanita)* — See (39) Mistletoe under General Diseases.
17. *Leaf Spots, Leaf Blotch, Spot Anthracnose, Anthracnose, Tar Spot* — Widespread. Small to large, round to irregular spots of various colors on leaves. See Figure 80. Widespread in rainy seasons. If severe, leaves may wither and drop early. Tips of twigs may also be spotted and later blighted. *Control:* If practical, spray as for Mummy Berry (above). See also Table 10 in the Appendix. For only a few plants, pick off and burn infected leaves. Avoid crowding plants.
18. *Bacterial Stem Canker of Blueberry* — Serious on the Pacific Coast. Water-soaked areas develop on last year's canes during the winter. Infected areas soon turn into well-defined, reddish-brown to black cankers. All buds are killed. Stems may be girdled and killed. Young plants may die. *Control:* Grow resistant varieties such as Burlington, June, Pioneer, Rancocas, Rubel and Weymouth. Apply bordeaux (4-4-50) twice in October and November.
19. *Drought and Winter Injury (mountain-laurel)* — Leaves gradually turn brown, starting at the tip or margins. Such leaves dry up and later drop off. *Control:* Plant in shady, protected locations. Water plants during dry periods in summer and fall. Mulch plants in early winter after ground is frozen. Protect exposed plants against winter winds by putting up burlap or canvas barriers.
20. *Black Mildew* — Primarily in the Gulf states. See (12) Sooty Mold under General Diseases.
21. *Fruit Rots (blueberry)* — Fruits rot on plant or after harvest. May be covered

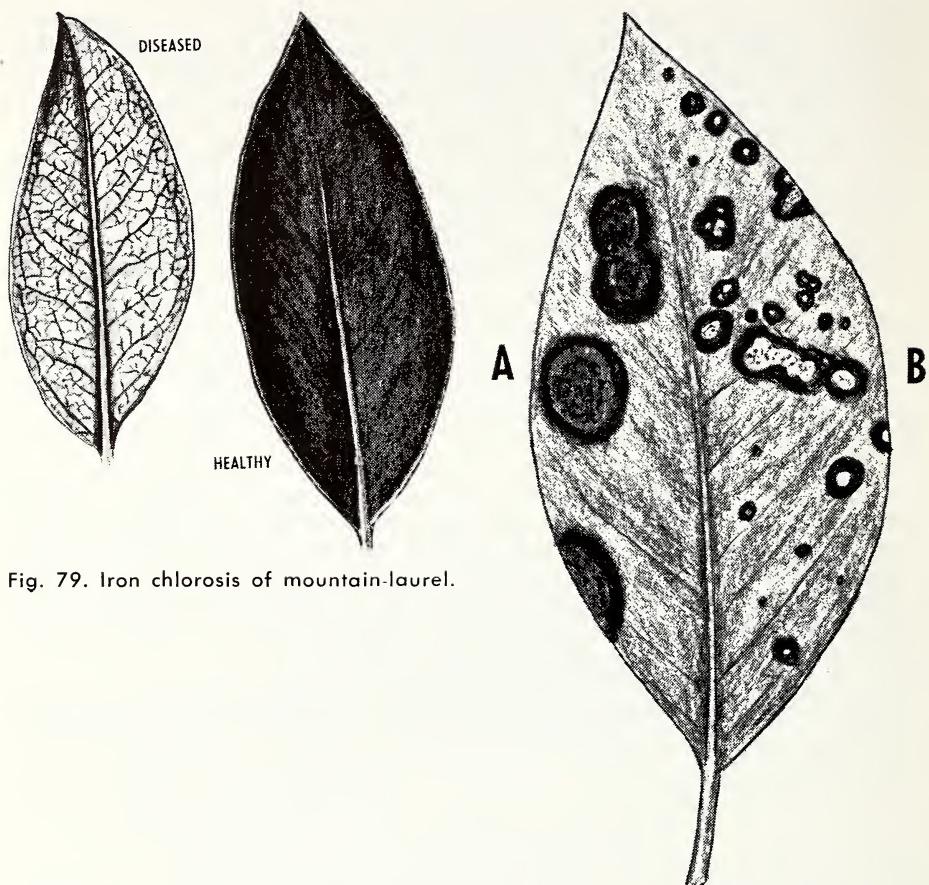


Fig. 79. Iron chlorosis of mountain-laurel.

Fig. 80. A. Leaf blight (*Phemopsis*), and B. Leaf spot (*Phyllosticta*) of mountain-laurel.

with a gray, brown, or black mold growth. *Control:* Same as for Mummy Berry (above).

22. *Blueberry Root Gall* — Galls on roots are white at first, later become dark brown, woody, and covered with bark. Stem cankers occur near the soil line. Small galls may occur on the twigs. *Control:* Plant resistant varieties such as Dixi, Jersey, and Rubel.
23. *Blueberry Red Leaf Disease* — Northeastern states on lowbush blueberry. Red leaves appear on certain branches with a white, feltlike layer on the undersurface. Some infected shoots die back each year. Fruit set is reduced. The causal fungus is related to those causing Red Leaf Gall, except that Red Leaf is systemic with the fungus, being perennial in the rhizome. *Control:* Dig out and destroy infected plants when first found.
24. *Bud-proliferating Gall* — Galls form at the soil line. Buds abort to form clusters of weak shoots, 1 to 6 inches tall. *Control:* Same as for Crown Gall (above).
25. *Root-feeding Nematodes* (awl, dagger, lance, pin, ring, root-knot, root-lesion, sheath, spear, sphaeronema, spiral, stubby-root, stylet or stunt) — Associated with

sickly, stunted, declining plants. *Control:* See (37) Root-knot under General Diseases.

BLOODLEAF — See Cockscomb

BLUEBEARD — See Lantana

BLUEBELLS-OF-SCOTLAND — See Bellflower

BLUE BONNET — See Pea

BLUE COHOSH — See Barberry

BLUE DAISY — See Chrysanthemum

BLUE DICKS — See Brodiaea

BLUE-EYED GRASS — See Iris

BLUE-EYED-MARY — See Snapdragon

BLUE GILIA — See Phlox

BLUEGRASS — See Lawnglass

BLUE LACEFLOWER — See Celery

BLUELIPS — See Snapdragon

BLUE MIST SPIREA — See Lantana

BLUETS — See Buttonbush

BOG LAUREL — See Blueberry

BOISDUVALIA — See Fuchsia

BOLTONIA, BONESET — See Chrysanthemum

BORAGE (*Borago*) — See Mertensia

BOSTON IVY — See Grape

BOUGAINVILLEA

1. *Leaf Spot* — Leaves spotted during rainy seasons. *Control:* Collect and burn fallen leaves in autumn. If needed, spray several times during rainy periods using zineb or manebo.

2. *Mosaic* — See (16) Mosaic under General Diseases.

BOUSSINGAULTIA — See Lythrum

BOUVARDIA

1. *Rust* — Southern states. Yellow, yellowish-orange or dark, powdery pustules on leaves. May cause some injury. *Control:* Pick off and burn spotted leaves. If practical, spray several times, 10 days apart, starting 2 weeks before rust normally appears. Use ferbam, zineb, or manebo. Indoors keep water off the foliage and space plants.

2. *Leaf Nematode* — Leaves develop dark, unsightly blotches. Flower clusters are deformed and stunted. See (20) Leaf Nematode under General Diseases.

3. *Root-knot* — Plants may be stunted and sickly with galls or knots on the roots. See (37) Root-knot under General Diseases.

BOWSTRING HEMP — See Sansevieria**BOXELDER — See Maple****BOX MYRTLE, BOX SANDMYRTLE — See Labrador-tea****BOXWOOD [BOX, DWARF or ENGLISH, EDGING, JAPANESE, KOREAN,
LITTLELEAF, MYRTLE-LEAF, ROSEMARY-LEAF, TREE or AMERICAN,
VARIEGATED] (Buxus)**

1. *Cankers, Diebacks, Twig Blight* — General and destructive. Infected branches often start growth later in the spring than normal ones. Leaves on such branches curl upward close to the stem and turn light green and finally straw-colored. Often follows winter injury. Twigs, branches, or main stems die back. Small, pinkish to black mounds often develop on affected parts. *Control:* Before growth starts in the spring, remove and burn all leaves on the ground and those lodged in twig crotches. Prune out dead twigs and branches as soon as noticeable. Cut out cankers on larger branches. Spray: (1) just after removing dead leaves and branches and before growth starts, (2) as new leaves are breaking out of the buds, (3) 2 and 4 weeks later. Use bordeaux (3-3-50), lime-sulfur (5 level tablespoons per gallon of water), fixed copper, ziram, ferbam, or phenyl mercury. Protect plants against Winter Injury (below). Maintain vigor by fertilizing and watering during droughts.
2. *Leaf Spots, Leaf or Tip Blights, Leaf Cast* — Leaves variously spotted. Leaves may

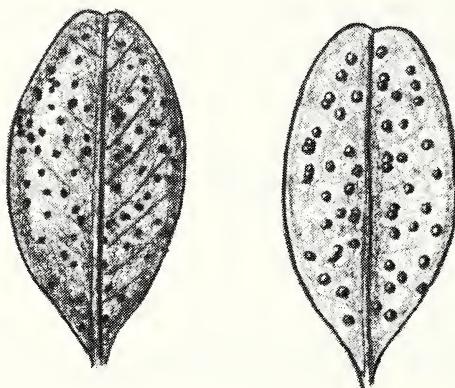


Fig. 81. *Macrophoma* leaf spot of boxwood.

become straw-colored, sometimes tan or brown, starting at the margins and tips. Conspicuous black dots may be evident on the upper leaf surface. See Figure 81. *Control:* Same as for Cankers (above). Protect plants against Winter Injury. See below.

3. *Winter Injury, Sunscald, Windburn* — Serious in northern states. Symptoms variable. Leaves may turn bronze-colored to rusty-brown or red with dead areas around the margin. Leaves dry in late spring. Leaves, twigs, even entire plants may die back. Injured bark may be split and peel. Stems are girdled, with the parts beyond later dying. *Control:* Erect burlap or canvas windbreaks to ward off drying winter winds and sun. Try spraying with Wilt-Pruf or a similar material in late fall. Fertilize in late fall or very early spring. Water plants thoroughly late in a dry fall just before the ground freezes. Then mulch plants liberally to prevent deep freezing. Check with your local nurseryman or extension horticulturist regarding mulching. In the spring, prune back dead branches to healthy wood.

4. *Root Rots* — Foliage sickly. Plants may wilt and die suddenly or gradually. Usually associated with nematodes. See under Apple, and (34) Root Rot under General Diseases.
5. *Nematodes* (burrowing, dagger, lance, needle, pin, ring, root-knot, root-lesion or meadow, sheath, spiral, stem, sting, stubby-root, stylet or stunt) — Plants weak, stunted, lack vigor. May wilt on hot, dry days. Leaves may be a sickly bronze to orange color. Plants gradually decline. Branches may die back. Roots stunted, often bushy, and dark. Root rot may follow nematode injury. *Control:* Drench soil around plant roots with Nemagon, Fumazone, or VC-13. See "Soil Treatment Methods and Materials" in the Appendix. Check also with your nurseryman, extension plant pathologist, or entomologist. Mulch, water, and fertilize to keep plants as vigorous as possible. Fumigate the planting site before replanting boxwood in infested soil. Young, bare-root plants may be disinfested of Root-knot (and possibly other nematodes) by dipping in hot water (118° F. for 30 minutes), then planting in clean or fumigated soil.
6. *Heart Rots, Trunk Rot* — See Wood Rot under Birch, and (23) Wood Rot under General Diseases.
7. *Thread Blight* — Southeastern states. See under Fig.

BOYSENBERRY — See **Raspberry**

BRACHYCOME — See **Chrysanthemum**

BRASSICA — See **Cabbage**

BRIDAL WREATH — See **Spirea**

BROCCOLI — See **Cabbage**

**BRODIAEA, TRIPLET LILY, BLUE DICKS, PRETTY-FACE,
CALIFORNIA-HYACINTH (*Brodiaea*)**

1. *Rusts* — Western states. Yellow, orange, reddish-brown or black, powdery pustules on leaves. Alternate host: none or wild grasses (*Agropyron* and *Elymus*). *Control:* Where serious enough, collect and burn rusted leaves after flowering. Apply zineb, maneb, or ferbam several times, 10 days apart. Start about 2 weeks before rust normally appears.

BROOM [PORTUGUESE, PURPLE, SCOTCH, SPIKE, WARMINSTER], DYER'S GREENWEED, DOUBLE-FLOWERED DYER'S GREENWEED, WOODWAXEN
(*Cytisus, Genista*); **BUNDLEFLOWER** (*Desmanthus*)

1. *Leaf Spot, Blight, Diebacks* — Small, irregular black spots on leaves. Spots enlarge rapidly forming a blotch or blight. Leaves drop early. Brown spots may develop on the stems. Shoots die back. Plants are often killed in 2 weeks. *Control:* Destroy infected plant parts. Spray weekly, starting when disease is first noticed, using bordeaux mixture or fixed copper and spray lime.
2. *Powdery Mildew* — Powdery, white mold patches on leaves. *Control:* Dust or spray twice, 10 days apart, using sulfur or Karathane.
3. *Rust* — See (8) Rust under General Diseases.
4. *Root Rot* — See under Apple, and (34) Root Rot under General Diseases. May be associated with root-lesion or meadow nematodes.

BROUSSONETIA — See **Fig**

BROWALLIA — See **Tomato**

BROWN-EYED-SUSAN — See **Chrysanthemum**

BRUSSELS SPROUTS — See **Cabbage**

BRYONOPSIS — See **Cucumber**

BRYOPHYLLUM — See **Sedum**

BUCHLOË — See **Lawngrass**

BUCKEYE — See **Horsechestnut**

BUCKTHORN [ALDER, CALIFORNIA or COFFEEBERRY, CAROLINA (YELLOW or INDIAN CHERRY), CASCARA, COMMON, DAHURIAN, GLOSSY, HOLLYLEAF or RED-BERRIED] (*Rhamnus*)

1. *Leaf Spots* — Widespread, but not destructive. Small, round to elongated, gray, brown, or black spots on leaves. *Control:* Usually not necessary. If needed, apply sprays at 10-day intervals during rainy periods. Use zineb, ferbam, or maneb.
2. *Rusts* — Widespread. Small, yellow to orange spots on leaves. Causes little damage. The rusts spread to nearby oats and grasses where they cause the destructive Crown Rust disease. See Figure 82. Buckthorn is a noxious weed in Iowa. In California one rust produces black pustules on coffeeberry and hollyleaf buckthorn.



Fig. 82. Crown rust on buckthorn (extreme closeup). Note aecial "cluster cups."
(Courtesy Dr. W. H. Bragonier)

3. *Wood Rots* — See under Birch, and (23) Wood Rot under General Diseases.
4. *Powdery Mildew* — See (7) Powdery Mildew under General Diseases.
5. *Sooty Mold* — Black, powdery mold patches on leaves following aphids or scales.
Control: Apply malathion to control insects.
6. *Root Rot* — See (34) Root Rot under General Diseases.

BUCKWHEAT-TREE (*Cliftonia*); SOUTHERN LEATHERWOOD (*Cyrilla*)

1. *Leaf Spots* — Spots of various sizes, shapes, and colors on leaves. *Control:* If serious enough, collect and burn fallen leaves. Spray during moist periods, using zineb, maneb, or ferbam.
2. *Rust* (southern leatherwood) — Southeastern states. See (8) Rust under General Diseases. *Control:* Same as for Leaf Spots.
3. *Black Mildew* — See (12) Sooty Mold under General Diseases.
4. *Brown Felt Canker* — See under Hackberry.

BUDDLEIA — See **Butterflybush**

BUFFALOBERRY — See **Russian-olive**

BUFFALOGRASS — See **Lawngrass**

BUGBANE — See **Anemone**

BUGLEWEED — See **Ajuga**

BUNCHBERRY — See **Dogwood**

BUNDLEFLOWER — See **Broom**

BUNYA-BUNYA — See **Araucaria**

BUR-MARIGOLD — See **Chrysanthemum**

BURNET — See **Rose**

BURNING-BUSH — See **Bittersweet and Beet**

BUSH-MALLOW — See **Hollyhock**

BUSH MORNING-GLORY — See **Morning-Glory**

BUSH-PEA — See **Pea**

BUTTER-AND-EGGS — See **Snapdragon**

BUTTERCUP — See **Delphinium**

BUTTERFLYBUSH [FOUNTAIN, JAPANESE, ORANGE-EYE BUTTERFLYBUSH or SUMMER-LILAC] (*Buddleia*); YELLOW-JESSAMINE, CAROLINA JESSAMINE (*Gelsemium*)

1. *Mosaic* (butterflybush) — Leaves mottled light and dark green, malformed, and tapered. See (16) Mosaic under General Diseases.
2. *Twig and Stem Canker* — See (22) Stem Canker under General Diseases.
3. *Root-knot* — Butterflybush is very susceptible. See (37) Root-knot under General Diseases.
4. *Sooty Mold, Black Mildew, Leaf Spot* — See (1) Fungus Leaf Spot, and (12) Sooty Mold under General Diseases.
5. *Root Rot* — See under Apple, and (34) Root Rot under General Diseases.
6. *Silky Thread Blight* (Carolina jessamine) — Southeastern states. See under Walnut.

BUTTERFLY-FLOWER — See **Tomato**

BUTTERFLY-PEA — See **Pea**

BUTTERFLYWEED (*Asclepias*); PHILIBERTIA

1. *Leaf Spots* — Spots of various sizes, colors, and shapes on leaves. *Control:* See under *Chrysanthemum*.
2. *Rusts* — Widespread. Yellow, yellowish-orange, reddish-brown or black, powdery pustules on leaves. Alternate hosts: Grama (*Bouteloua* spp.), cord grasses (*Spartina*), unknown, or none. *Control:* Pick off and burn rusted leaves. If practical, spray with ferbam or zineb, several times, 10 days apart. Start a week or more before rust normally appears.
3. *Mosaic* (butterflyweed) — Plants dwarfed with stunted, mottled, distorted leaves. Irregular, yellowish-green blotches on leaves. *Control:* Destroy infected plants when first found. Control aphids which transmit the virus. Use malathion or lindane.
4. *Root Rot* — See under *Geranium*, and (34) *Root Rot* under General Diseases.
5. *Powdery Mildew* (philbertia) — Powdery, whitish mold on leaves. *Control:* If needed, apply Karathane or sulfur twice, 10 days apart. Start when mildew is first evident.

BUTTERNUT — See Walnut**BUTTONBUSH (*Cephaelanthus*); CHINCHONA; BEDSTRAW (*Galium*); BLUETS (*Houstonia*); PARTRIDGEBERRY (*Mitchella*); JUNGLEFLAME (*Ixora*)**

1. *Leaf Spots, Leaf Blight* — Spots of various sizes, shapes, and colors on leaves. *Control:* Pick off and burn affected leaves. If serious enough, apply zineb, maneb, ferbam, or fixed copper during wet periods.
2. *Powdery Mildews* (bedstraw, buttonbush) — Widespread. See (7) *Powdery Mildew* under General Diseases. *Control:* Apply sulfur twice, 10 days apart.
3. *Rusts* (bedstraw, buttonbush, houstonia) — See under *Bellflower*, and (8) *Rust* under General Diseases. Alternate hosts: none or *Spartina*, *Distichlis*, *Aristida*, or *Sisyrinchium*.
4. *Downy Mildews* (bedstraw, houstonia) — Uncommon. See (6) *Downy Mildew* under General Diseases.
5. *Root-knot* — See (37) *Root-knot* under General Diseases.
6. *Black Mildew* (partridgeberry) — Unsightly black blotches on foliage. *Control:* Same as for *Leaf Spots* (above). Apply malathion to control insects.
7. *Root Rot* — See under *Apple*, and (34) *Root Rot* under General Diseases. Sickly, declining plants may be infested with nematodes (e.g., burrowing).
8. *Thread Blight* — Southeastern states. See under *Walnut*.
9. *Stem Rot* (partridgeberry) — See (21) *Crown Rot* under General Diseases.

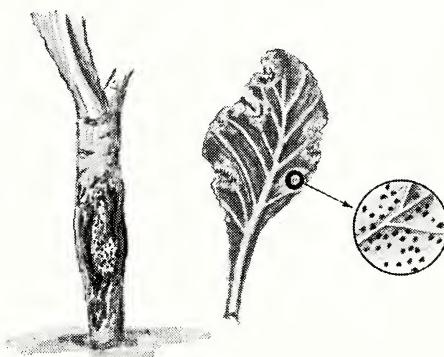
BUTTON SNAKEROOT — See Chrysanthemum**BUTTONWOOD — See Sycamore****BUXUS — See Boxwood****CABBAGE, BROCCOLI, BRUSSELS SPROUTS, CAULIFLOWER, CHINESE CABBAGE or PE-TSAI and PAK-CHOI, KALE, FLOWERING KALE, KOHLRABI, MUSTARD [BLACK, LEAF, WHITE], RAPE, RUTABAGA, TURNIP (*Brassica*); STONECRESS (*Aethionema*); ALYSSUM, YELLOWTUFT,**

GOLDENTUFT, GOLDDUST (*Alyssum*); ROCKCRESS, WALLCRESS (*Arabis*); HORSERADISH (*Armoracia*); PURPLE ROCKCRESS (*Aubretia*); WALLFLOWER (*Cheiranthus*); SCURVYWEED (*Cochlearia*); SEAKALE (*Crambe*); TOOTHWORT (*Dentaria*); WHITLOWGRASS (*Draba*); ERYSIMUM, WALLFLOWER [ALPINE, SIBERIAN, WESTERN, PRAIRIE ROCKET] (*Erysimum*); DAMESROCKET, ROCKET (*Hesperis*); CANDYTUFT (*Iberis*); GARDEN CRESS, PEPPERGRASS (*Lepidium*); SWEET ALYSSUM (*Lobularia*); HONESTY (*Lunaria*); STOCK [COMMON or TEN-WEEKS, EVENING- or NIGHT-SCENTED] (*Matthiola*); WATERCRESS (*Nasturtium* or *Rorippa*); RADISH (*Raphanus*); SMELOWSKIA; DESERTPLUME (*Stanleya*)

1. *Yellows*, *Fusarium Wilt* — General. Leaves turn a dull yellow, curl, die, and fall starting at the base of the plant. May show one-sided growth. Plants sickly and stunted. Brown streaks inside stems. Seedlings yellow, wilt, and die. Most serious at high soil temperatures. Often mistaken for Black Rot. See Figure 29B under General Diseases. *Control*: Start disease-free seed in disease-free soil. Seed may be disinfected by treating in hot water (see under Blackleg below). Plant resistant varieties, where adapted: *Cabbage* — All-head Select, Badger Ballhead Y.R., Badger Market, Badger Shipper, Bugner, Charleston Wakefield, Empire Danish, Globe Y.R., Glory 61, Greenback Y.R., Improved Wisconsin All Seasons, Improved Wisconsin Ballhead, Jersey Queen, Marion Market, Market Master, Racine Market, Red Hollander, Red Yellows Resistant, Resistant Flat Dutch, Resistant Danish, Resistant Detroit, Resistant Glory, Resistant Golden Acre, Wisconsin Copenhagen, Wisconsin Golden Acre, Wisconsin Greenback Y.R., Wisconsin Pride, and many more; *Cauliflower* — Early Snowball; *Broccoli* — Calabrese, Di Cicco, Early Green Sprouting, Grand Central, Midway, and Waltham 29; *Kale* — Siberian Kale; *Radish* — Red Prince.

2. *Blackleg, Canker, Dry Rot* — General east of the Rocky Mountains. Light brown or gray spots on stems, leaves, and seed stalks in which black dots develop. Leaves

Fig. 83. Blackleg of cabbage. The black dots are fungus (*Phoma*) fruiting bodies.



may wilt, discolor, and die. Stem is girdled, blackens, and rots. Plants often stunted. May break over as head enlarges. Taproot often decays. See Figure 83. *Control*: Collect and burn tops after harvest. Avoid overcrowding plants. Plant in well-drained soil. Three-year rotation. Keep down cruciferous weeds. Plant disease-free, western-grown seed. If disease has been a problem in the past, soak untreated

cabbage and *Brussels sprouts* seed in hot water (exactly 122° F. for 25 minutes). For *cauliflower*, *collards*, *broccoli*, *kale*, *kohlrabi*, *rutabaga*, and *turnip* seed, soak at the same temperature, but for 20 minutes. For *radish*, *cress*, and *mustard* seed soak only 15 minutes. Soak *stock* seed at 130° F. for 10 minutes. Then dry the seed carefully at room temperature and dust with thiram, captan, chloranil, or Semesan before planting. See Table 13 in the Appendix. Control cutworms and cabbage maggots by spraying a 10-inch strip of soil over the row immediately after planting or transplanting. Repeat 10 days later. Use aldrin or chlordane. Control other insects using DDT and malathion. Check with your county agent or extension entomologist for the latest insect recommendations. Treat seedbed as for *Wirestem* (below).

3. *Black Rot, Bacterial Wilt, or Blight* — General in warm, moist seasons. Seedlings yellow, wilt, and collapse. V-shaped, yellow, brown, or dark green areas with blackened veins usually starting at the leaf margin. Lower leaves of *cauliflower* and *stock* turn yellow or brown and drop early. One-sided growth is common. Plants and flowers are dwarfed. May rot quickly. Black ring inside stem when cut across. *Control*: Same as for *Blackleg* (above). Maintain balanced soil fertility. *Cabbage* varieties differ in resistance. Resistant *mustard*: Florida Broadleaf. Resistant *kale*: Dwarf Siberian.
4. *Wirestem, Seed Rot, Damping-off, Collar Rot, Rhizoctonia Disease* — General. Seeds rot. Seedlings wilt, curl, and collapse from rot at the soil line. Older stems are girdled by brown or black cankers, shrivel, turn dark and woody (*wirestem*). Transplanted seedlings make slow growth or die. Most serious under cool, wet conditions. Dark, firm rot of base of *cabbage* head. Outer leaves wilt, darken at base. See (21) *Crown Rot*, and (22) *Stem Blight* under General Diseases. *Control*: Same as for *Blackleg* (above). If needed, dust seed of *radish*, *cress*, and *mustard* with thiram or Semesan. Avoid overcrowding, overfertilizing with nitrogen, and overwatering plants. Apply one of the following treatments to soil or around the base of young plants: (a) a soil drench of Terraclor 75 (PCNB) and captan 50 (sold as Terracap and Orthocide Soil Treater "X"), $\frac{1}{2}$ tablespoon of each per gallon, applied over 20 square feet just after planting, (b) spread $\frac{1}{2}$ cup each of Terraclor 20 and captan 7 $\frac{1}{2}$ per cent dust uniformly over 50 square feet and rake or rototill evenly into the top 3 inches of soil before planting, (c) apply ziram or chloranil sprays in the seedbed at 3- to 7-day intervals to wet both seedlings and soil, or (d) treating soil with Vapam or Mylone 3-4 weeks before seeding controls diseases, weeds, and nematodes.
5. *Clubroot* — General. Yellowish, sickly leaves which wilt on hot days. Plants stunted. May die before maturing. Often fail to produce decent heads. Roots greatly enlarged and distorted with warty overgrowths or "clubs." See Figure 48 under General Diseases and Figure 84. *Control*: See (35) *Clubroot* under General Diseases. In addition, locate the seedbed or flower bed in an area where no infested soil can be washed. The seedbed soil should be clean or pasteurized (pages 437-44). Apply Terraclor 75 per cent in the transplanting water using 1 ounce per gallon. Drench flower bed areas. Apply $\frac{3}{4}$ pint per plant. In furrow drenches of Vapam or V.P.M., (1 pint to 100 feet of row) 2 to 3 weeks before planting, give excellent Clubroot and weed control. Follow the manufacturer's directions. Plant resistant varieties where adapted; for example, stock *turnip*: Bruce, Dale's Hybrid, and May; *Rutabagas*: Immuna II, Resistant Baugholm, and Wilhembsburger; some varieties of *stock* and *wallflower* are also resistant. *Radish* is usually resistant. Resistant *cabbage* varieties may be available soon. Keep down weeds in the mustard family.

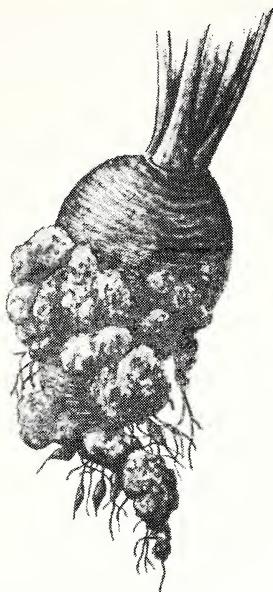


Fig. 84. Clubroot of turnip.

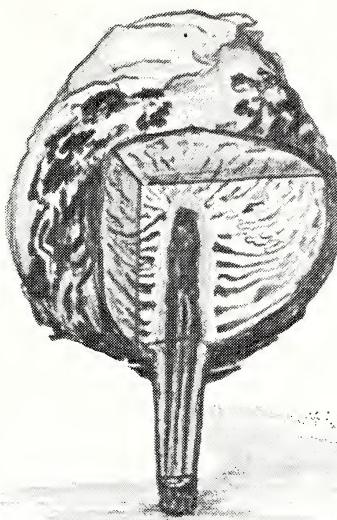


Fig. 85. Bacterial soft rot of cabbage.

6. *Downy Mildew* — General in cool, wet areas. Seedling leaves appear moldy. Pale green to yellow spotting of the upper leaf surface of older leaves, followed by purpling, browning, wilting, and dying of these leaves. A white or gray mold growth forms on the corresponding undersurface of affected leaves. Spots also form on heads, stems, flower stalks, and flowers. Spots on the heads or curds are black. Young plants may blacken and die. Irregular, brown or black areas may form in fleshy turnip or radish roots. *Control:* Treat seed as for Blackleg (above). Maintain balanced soil fertility. Avoid overcrowding and sprinkling the foliage. Rotate. Plant in well-drained soil. Pick off and burn infected plant parts, as they appear. In the seedbed or in the field, during cool, rainy periods, apply chloranil, maneb or zineb at 5-day intervals. Certain strains of broccoli, cauliflower, Chinese cabbage, kale, mustard, radish, rutabaga, and turnip are resistant.
7. *Bacterial Soft Rot, Stump Rot* — Cosmopolitan. Slimy, soft head, stem, and root rot with a foul odor. Head falls away easily leaving a slimy stump. Often follows other diseases, insects (worms and maggots), or freezing injury. See Figure 85. *Control:* Store only dry, sound heads just above freezing. Collect and burn, compost, or bury plant debris after harvest. Control insects and other diseases. See under Blackleg (above). Avoid injuries while cultivating or harvesting. Soak bedding roots of horseradish in a 1:1,000 solution of mercuric chloride for 20 minutes. See Table 13 in the Appendix. *Chinese cabbage* varieties differ in resistance.
8. *Head and Fleshy Root Rots* — Primarily a storage problem. See under Carrot.
9. *Leaf Spots, Black Leaf Spot, Anthracnose* — General. Pale yellow or white, tan, gray, brown, dark green, or black spots on the leaves, petioles, stalks, and seed pods. Leaves may wilt, shrivel, and die early. Seedlings may be killed. Cauliflower and broccoli heads are discolored. Common in the seedbed, in the field, and in storage. *Control:* Same as for Blackleg (above). In addition, avoid injuring heads.

- Refrigerate heads promptly after harvest. Spray in the seedbed as for Downy Mildew (above). In the garden, where practical, apply zineb, ziram, maneb, or chloranil several times, 7 to 10 days apart, during rainy periods. Southern Curled Giant mustard is highly resistant to Anthracnose.
10. *Bacterial Leaf Spots, Pepper Spot* (primarily horseradish, radish, turnip, cauliflower, cabbage, broccoli, Chinese cabbage) — Widespread. Small, dark green, brown to purplish, water-soaked (or tan to white) spots on the leaves between the veins. Spots later enlarge, dry out and become dark and angular. Dark spots may also occur on the petioles and stems. Leaves may wither and drop early. *Control:* Same as for Blackleg (above). Apply fixed copper or streptomycin several times, 10 days apart, starting when spots are first evident.
 11. *White Mold or Blight, Drop, Cottony Rot, Watery Soft Rot, Southern Blight* — General. Water-soaked areas on the stem and lower leaves. Leaves later wilt, often drop. Plant collapses. Cottony mold growth on stem and head. Head may become a wet, slimy mass. Roots may decay. *Control:* Same as for Wirestem (above). Dig up and burn infected plants plus 6 inches of surrounding soil. In addition, store only dry, sound heads. Handle carefully. If practical, pick off and burn fading flowers. Varieties differ in resistance.
 12. *Root-knot, Cyst Nematodes* — Similar to Clubroot (above) but galls on roots are smaller and usually more evenly distributed. Plants sickly and stunted. *Control:* See under Bean, and (37) Root-knot under General Diseases.
 13. *Tipburn* — Primarily a problem of cabbage and cauliflower. Tips and margins of leaves turn pale, brown, or black and shrivel. If severe, outer leaves may die and the tips of the younger and inner leaves are scorched and "papery." Plants usually stunted. Head is flabby and weak. *Control:* Maintain balanced soil fertility (especially the ratio of phosphorus and potash) based on a soil test. Early and kraut *cabbage* varieties are normally somewhat resistant (e.g., Wisconsin Copenhagen, Bonanza, Resistant Detroit, and Wisconsin Golden Acre). Danish types are commonly affected.
 14. *White-rust, White Blister* — Widespread in cool, wet weather. Pale yellow spots on the upper leaf surface with white, powdery, blister-like pustules on the underside of leaves, smaller stems, seed pods, and flower parts. Affected parts may be swollen and distorted. Plants may be stunted. See figures 23A, B, and D under General Diseases. *Control:* Destroy infected plant parts when seen. Destroy plant debris after harvest. Keep down weeds. Long rotation with plants outside the cabbage or mustard family. Where serious, apply chloranil or fixed copper several times, 7 to 10 days apart, starting before White-rust normally appears. Try soaking *horseradish* roots in hot water (111° F.) for 10 to 15 minutes. Strains of Bohemian *horseradish* are resistant.
 15. *Boron Deficiency, Brown Heart or Rot* — Primarily a problem of broccoli, cauliflower, cabbage, radish, rutabaga, and turnip in alkaline soils. Leaves are often mottled or scorched at the edges. May roll, become very brittle and deformed. Plants may be dwarfed with very narrow leaves. Stems (stalks) may be hollow and edible roots are often "glassy," gray, brown, or black inside. Cauliflower curd gradually turns brown. Affected heads are bitter and tough. *Control:* Have the soil tested. Apply borax as recommended. Avoid overliming. Fairly resistant *cabbage* varieties: All-head Select, Wisconsin All Seasons, Wisconsin Ballhead, and Wisconsin Hollander No. 8.
 16. *Gray-mold Blight, Botrytis Blight* — Water-soaked, grayish-green to brownish spots and rotting of outer leaves and stem. Young plants may wilt and die. Flowers may be spotted and rotted. Affected areas may be covered with a coarse gray mold.

Serious storage problem. *Control:* Same as for Bacterial Soft Rot (above). Space plants. Avoid overwatering. If practical, spray as for Downy Mildew (above). Indoors, keep down the humidity and increase the air circulation.

17. *Mosaics, Flower Breaking* — Symptoms variable. May be masked in hot weather. Leaves usually more yellow than normal. May drop prematurely. Often distorted, mottled, light and dark green or yellow, and crinkled. Cabbage leaves often show black flecks or spots (stippling). Plants may be stunted and bushy. Stock, dames-rocket, sweet alyssum, and wallflower flowers may show blotches or streaks. White and yellow *stock* varieties do not show flower breaking. See Figure 86. *Control:* Destroy affected plants when first found. Keep down weeds (especially wild mustards, charlock, shepherds-purse, yellow-rocket, and pennycress) in and around the seedbed and garden area. Resistant or tolerant *cabbage* varieties include Badger Ballhead Y. R., Badger Market, Empire Danish, Improved Wisconsin Ballhead,

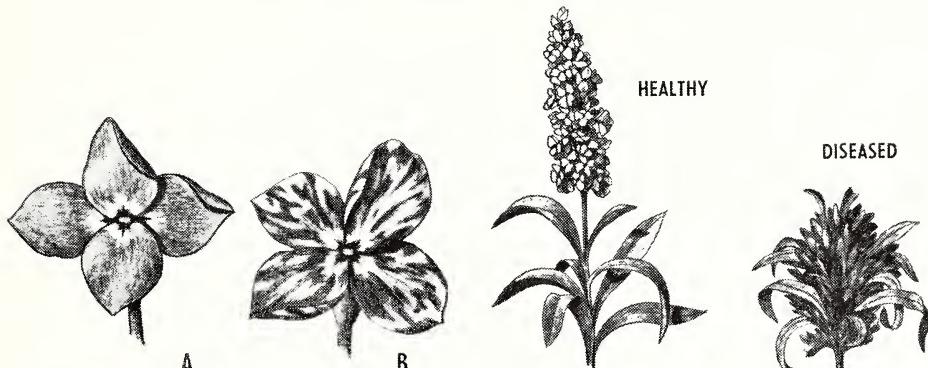


Fig. 86. Mosaic or flower breaking of stock. A. Healthy. B. Diseased.

Fig. 87. Curly-top of stock.

Improved Wisconsin All Seasons, and Penn State Ballhead. *Stock* varieties also vary in resistance. Control insects, especially aphids and cabbage worms, which transmit the viruses. Use malathion and DDT at about 5-day intervals. Or grow seedlings under fine screening. See under Blackleg (above).

18. *Black Ringspot, Ring Necrosis* — Symptoms variable. Small, yellow then black, concentric rings or spots on cabbage and older broccoli leaves. Leaves may curl, crinkle, and drop early. Small, light and dark green or yellowish, mottled areas on cauliflower, broccoli, stock, and honesty leaves. Turnip and horseradish leaves are yellowish, mottled, crinkled, and stunted. Irregular, dark green areas appear in the yellowed leaves. Roots may show black flecks when cut. Colored stock and honesty flowers show light flecks and streaks. *Control:* Same as for Mosaics (above). If practical, surround the seedbed with screening to keep out insects.
19. *Curly-top, Brittleroot* (primarily horseradish and stock) — Western half of the United States. Outer and later the inner leaves are narrow, curled, and puckered; roll inward and wilt. *Stock* plants are stunted and bushy. May turn yellow, white or purple, wilt and die in 2 or 3 weeks. When cut, *horseradish* roots are yellowish-tan with a ring of black dots in the center tissue. Roots later become brown to black and brittle. See Figure 87. *Control:* Destroy infected plants when first found. Plant virus-free horseradish roots. Plant early. Control leafhoppers which transmit the virus by spraying weekly with DDT and malathion. See under Blackleg (above).

20. *Aster Yellows* — See (18) *Yellows* under General Diseases.
21. *Scab* (primarily cabbage, radish, rape, rutabaga, and turnip) — Rough, raised, scabby areas on the surface of the root. *Control:* Work plenty of organic matter into the soil. See under Beet and Potato.
22. *Root Rots, Black Root* — General on radish. Leaves may discolor, wilt, and die. Plants may wilt easily or suddenly collapse. Roots and crown often decay. Dark spots at base of side roots. Spots enlarge to form metallic gray to black areas on the fleshy root. Entire root system may die. Fleshy root may be distorted, constricted, and turn black. Most common on the White Icicle-type radish. *Control:* Avoid heavy, wet, poorly drained soil. Treat the soil with a soil fumigant (e.g., Vapam, V.P.M. Soil Fumigant, Mylone, or formaldehyde) before planting (see pages 404-44). Grow resistant *radish* types (e.g., colored and late varieties). Rotate 3 or 4 years with plants outside the cabbage family. Burn or plow under deeply all crop debris after harvest. Treat seed as for Blackleg (above).
23. *Whiptail, Molybdenum Deficiency* (primarily cauliflower, broccoli, cabbage, and Brussels sprouts in very acid, heavily fertilized soils) — Leaves long and narrow, ruffled, thickened, grayish-green, and very brittle. Plants stunted. If severe, head may be absent. *Control:* Have the soil tested. Apply hydrated lime so soil reaction (pH) will be near neutral. The addition of about 1 ounce of ammonium molybdate per 1,000 square feet has given good control. May apply with fertilizer, in transplant water (1 ounce to about 12 gallons of water), or through foliar sprays. Check with a local grower, your county agent, or extension horticulturist. Varieties differ considerably in resistance.
24. *Powdery Mildew* — White, powdery mold patches on leaves and stems. If severe, leaves may be distorted, yellow to brown, and drop early. *Control:* If serious enough, apply sulfur or Karathane. Otherwise same as for Blackleg (above).
25. *Crown Gall* — See under Asparagus, and (30) *Crown Gall* under General Diseases.
26. *Rust* (garden cress, mustards, peppergrass, smelowskia, stanleya) — Small, yellowish spots on the leaves. Alternate host: wild grasses. *Control:* None usually necessary.
27. *Verticillium Wilt* — Plants may or may not be stunted. Lower leaves turn yellow and wilt. Disease progresses up the stem. Dark streaks occur inside the stem. See (15B) *Verticillium Wilt* under General Diseases. *Control:* Plant in clean or sterilized soil (pages 437-44).
28. *Web Blight* — Southeastern states. See under Bean.
29. *Oedema, Intumescence* — Primarily an indoor problem with broccoli, Brussels sprouts, cabbage, cauliflower, and kale. Small wartlike or ridgelike growths on the underside of leaves. Corresponding upper side may be depressed. The growths become white, later turn yellow or brown and become corky in texture. Permanent injury is rare if environmental conditions are changed. *Control:* Maintain an even soil moisture supply. Increase air circulation. Avoid overwatering and forcing plants too rapidly. Avoid use of copper sprays. Plant where winds will whip plants.
30. *Other Root-feeding Nematodes* (dagger, lance, nacobus, pin, reniform, root-lesion rot, spear, spiral, sting, stubby-root, stylet or stunt) — Mostly in southern states. Associated with sickly, stunted plants. Roots short, bushy, and die back. *Control:* Same as for Root-knot (above).

CACTUS: CEREUS (many diverse species); **SAGUARO** (*Cereus, Carnegiea*); **BARREL, STAR, SEA-URCHIN** (*Echinocactus* or *Ferocactus*); **THANKSGIVING, CRAB** (*Epiphyllum*); **PINCUSHION, FISHHOOK** (*Mammillaria*); **PRICKLYPEAR, CHOLLA, TUNA** (*Opuntia*); **ORGAN-PIPE** (*Pachycereus* or *Lemaireocereus*); **CHRISTMAS** (*Schlumbergera*); **ZYGOCACTUS**

1. *Corky Scab* — Pale, yellowish-green spots on the stems and shoots which often become irregular corky or rusty areas and may become sunken. Spots may remain smooth and grayish-white. Shoots may die. *Control:* Avoid overwatering, overcrowding, and applying too much fertilizer at one time. Avoid low potassium and high sodium content in the soil; keep the calcium level high. Plant in well-drained, sandy soil. Increase the light and air circulation. Decrease air humidity.
2. *Glassiness* — Dark green, somewhat transparent spots which finally turn black. Shoots may die back. Otherwise same as for Corky Scab (above).
3. *Stem and Root Rots, Cutting Rots, Wilts, Anthracnose, Cladode Rot, Seedling Blight* — Cuttings, stems, and branches discolored (yellow, light to dark green, brown, or black) or spotted, gradually or suddenly wilt and rot. May become slimy and collapse (Bacterial Soft Rot). A gray or black mold may grow on affected tissues. Roots decay. May be associated with nematodes (e.g., cyst, lance, root-knot, root-lesion, spiral, styllet or stunt). *Control:* Cut out and destroy infected plant parts. Plant in sterilized soil (pages 437-44). Avoid overwatering and wounding plants. Keep down air humidity. Sterilize seeds and disease-free cuttings by dipping in normal Semesan solution for 5 minutes before planting. Captan sprays at 10- to 14-day intervals may be beneficial. Keep water off aboveground parts.
4. *Bud Drop* — Buds fall early, especially on Christmas cacti. Plants may be stunted. *Control:* Fertilize adequately. Maintain uniform soil moisture. Avoid large temperature changes, cold drafts, and cold water on the foliage.
5. *Scorch, "Sunscald"* — Segments turn reddish-brown and die. Young spots are "zoned" with grayish-brown, cracked centers. *Control:* Avoid high temperatures and too much sun. Otherwise same as for Bud Drop (above).
6. *Black Mildew* — Florida. See (12) Sooty Mold under General Diseases.
7. *Root-knot, Cyst Nematode* — See (37) Root-knot under General Diseases.

CAESALPINIA — See **Honeylocust**

CALABASH — See **Cucumber**

CALADIUM — See **Calla**

CALATHEA — See **Rabbit Tracks**

CALCEOLARIA — See **Snapdragon**

CALENDULA — See **Chrysanthemum**

CALIFORNIA-BLUEBELL — See **Phacelia**

CALIFORNIA FREMONTIA — See **Phoenix-tree**

CALIFORNIA FUCHSIA — See **Evening-primrose**

CALIFORNIA-HYACINTH — See **Brodiaea**

CALIFORNIA-LAUREL — See Avocado**CALIFORNIA-POPPY — See Poppy****CALIFORNIA-ROSE — See Morning-glory****CALIFORNIA SWEETSHRUB — See Calycanthus**

CALLA [COMMON, GOLDEN, PINK, WHITE], CALLA LILY (*Zantedeschia*); CHINESE EVERGREEN (*Aglaonema*); ANTHURIUM; DRAGONROOT, JACK-IN-THE-PULPIT (*Arisaema*); CALADIUM; DASHEEN, ELEPHANTS-EAR (*Colocasia*); DIEFFENBACHIA; HOMALOMENA; CERIMAN (*Monstera*); NEPHHTHYTIS or SYNGONIUM; PHILODENDRON (many species and horticultural varieties); POTROS or IVY-ARUM (*Scindapsus*); YAUTIA, MALANGA (*Xanthosoma*)

1. *Bacterial Soft Rot, Leafstalk Rot* (caladium, calla, dasheen, dieffenbachia) — Slimy, wet, often foul-smelling rot of the stem, leaf stalks, flower stalks, and underground parts. Leaves and flower stalks may suddenly wilt, turn yellow or brown, collapse, and die. *Control:* Destroy infected plants and rotted corms, rhizomes or tubers. Rotate. Plant dormant, disease-free *calla* corms or rhizomes soaked 30 to 60 minutes in a 1:1,000 solution of mercuric chloride or formalin (1 to 50 dilution with water). Soak *dieffenbachia* canes in streptomycin (200 parts per million) for 15 minutes. Wash with running water and plant shallow in light, well-drained soil, sterilized if possible (pages 437-44), or where disease has not been present in the past. Keep the starting temperature above 70° F. and below 90° F. Avoid injuries to plants, overwatering, and excessive nitrogen fertilization. Spraying every 4 to 5 days with streptomycin, starting when the first symptoms appear, may be beneficial. Keep down the humidity. Propagate only from disease-free plants.
2. *Tuber, Corm, Stem (Cane), Root and Rhizome Rots, Cutting Rots* — Plants often stunted; leaves turn yellowish, later wither and die. Plants may not blossom or flowers may be deformed and decayed. Underground plant parts, or stem at the soil line, may rot. Plants collapse or are easily pulled up. See Figure 88. *Control:* Same as for Bacterial Soft Rot (above). Commercial growers dip 2-foot sections of hardened *dieffenbachia* canes (1 to 1½ inches in diameter) in hot water (120° F.) for 40 to 60 minutes. Canes are cooled and placed in sterilized sphagnum moss until new growth starts. The canes are then cut into pieces, each with a single bud, and planted. Soak dormant *caladium* tubers in hot water (122° F.) for 30 minutes. Cool and plant in clean soil. Treat *philodendron* canes as for Bacterial Leaf and Stem Rot (below). Dip hardened bare-root *nephthytis* (*Syngonium*) in hot water (120° F.) for 30 minutes. Cool and plant in sterilized soil. Take tip cuttings from *Chinese evergreen*. Drench soil with mixture of Terraclor 75 per cent (1 tablespoon per gallon of water) and ferbam 76 per cent (1½ tablespoons per gallon). Use 1 pint per square foot.
3. *Root-knot, Other Nematodes* (burrowing, root-lesion or meadow, spiral) — Internal discolored spots may be evident in *caladium* tubers. Plants may be sickly and stunted, gradually decline in vigor due to stubby, discolored roots. *Control:* Nurserymen soak bare-root *philodendron* and *Chinese evergreen* plants in hot water (122° F.) for 10 minutes before planting. Soak dormant *caladium* tubers as for Tuber Rot (above).
4. *Spotted Wilt* (calla) — Numerous, whitish-yellow flecks, spots, streaks, and even zoned rings on the leaves, flower stalks, and flower buds. Leaf spots may later turn brown. Leaves and flowers may be twisted and deformed. Pale greenish

blotches and streaks form on white flowers and on green buds. *Control:* Destroy infected plants when first found. Plant disease-free nursery stock. Control thrips with frequent DDT or malathion sprays. Keep down weeds.

5. *Mosaics* — Leaves may be curled, show a yellowish mottle. Plants are stunted. *Control:* Same as for Spotted Wilt (above). Control the virus-carrying aphids with malathion sprays.

6. *Leaf Spots, Anthracnose, Leaf and Flower Blight* — Small to large, round to irregular, spots of various colors on the leaves, flower stalks, and flowers. Spots may enlarge and run together forming irregular blotches. Severely infected leaves may wilt, wither, and die prematurely. Certain spots have a border of a different color.

Fig. 88. Root rot of calla.



Control: Pick off and destroy severely spotted leaves. Keep down weeds. Indoors, avoid sprinkling the foliage, overcrowding, and overwatering. Keep the temperature and humidity as low as practical. Control insects with a mixture of DDT and malathion. Apply ferbam, zineb, maneb, or captan sprays during rainy periods.

7. *Bacterial Leaf Spot or Rot of Dieffenbachia* — Small, yellow to yellowish-orange spots on the leaves. Centers of spots may be dull and watery-green. In wet weather the spots often enlarge and run together. Leaves may turn yellow, wilt, and die. During dry weather the spots remain small, dry, reddish-brown specks. *Control:* Pick off and burn severely spotted leaves. Space plants. Keep water off the foliage. Lower the air temperature. Spraying with streptomycin may be beneficial.

8. *Bacterial Leaf and Stem Rot of Philodendron* — Small, irregular, water-soaked spots on leaves and stem. Spots enlarge rapidly during warm, moist weather. Leaves and leaf stalks may rot, collapse, and become mushy. *Control:* Remove and burn infected plant parts when first found. Destroy dilapidated plants. Scrub and thoroughly dry containers before reusing. Plant in sterilized soil (pages 437-44). Where practical, spray at 5- to 10-day intervals, using streptomycin (200 parts per million) following the manufacturer's directions. Commercial growers control Stem Rot by soaking propagating canes for 30 minutes in hot water (120° F.). Canes are then cooled and rooted in sterile sphagnum moss.

9. *Philodendron Leaf Yellowing, Dieback* — Indoor problem. Leaves may be stunted, turn yellow, and drop early. Shoot tips may die back. *Control:* Increase light and humidity. Avoid overfertilizing, overwatering, and planting in heavy, poorly drained soil. Repot plants if needed.
10. *Rust* (Jack-in-the-pulpit) — Small, lemon-yellow pustules on the leaves and spathe. Foliage later turns yellow and dies. Plants do not flower. *Control:* Pull up and burn infected plants. The rust fungus is perennial.
11. *Sooty Mold* — See (12) Sooty Mold under General Diseases.

CALLIANDRA, FALSE-MESQUITE, POWDER-PUFF TREE (*Calliandra*)

1. *Root Rot* — See (34) Root Rot under General Diseases.
2. *Rust* (false mesquite) — Arizona. See (8) Rust under General Diseases.

CALICARPA — See Lantana

CALLIRHOË — See Hollyhock

CALLISTEPHUS — See Chrysanthemum

CALLUNA — See Heath

CALOCHORTUS — See Mariposa Lily

CALONYCTION — See Morning-glory

**CALYCANTHUS, CAROLINA ALLSPICE, MOUNTAIN SPICEWOOD,
CALIFORNIA SWEETSHRUB (*Calycanthus*)**

1. *Twig and Branch Canker* — See under Maple, Chestnut, and (22) Stem Blight under General Diseases. Prune out and burn infected parts.
2. *Crown Gall* — See under Apple, and (30) Crown Gall under General Diseases.
3. *Powdery Mildew* — See (7) Powdery Mildew under General Diseases.

CAMASS (Camassia) — See Colchicum

CAMELLIA [COMMON, SASANQUA] (*Camellia*)

1. *Flower Blight* — Widespread in southern states and along the Pacific Coast. Numerous, small, brown specks or spots on flowers. Whole flower soon turns dull brown, withers, and drops. Large, black bodies (sclerotia) form in the center of old flowers and serve to perpetuate the causal fungus. See Figure 89. *Control:* During early winter apply Terraclor (PCNB) dust or spray to the soil surface or leaf litter beneath plants and an area 10 feet beyond. Follow the manufacturer's recommendations. Repeat one month later. Remove and burn all fading flowers as soon as disease is evident. During bloom apply zineb or Thylate (1 tablespoon per gallon) at 3-day intervals if the period is rainy. Buy only certified, disease-free, bare-rooted plants. Before planting remove and burn all flower buds showing color.
2. *Dieback, Cankers, Graft Blight* — Widespread and serious in southern states. Foliage wilts, turns dull green, and dies from slightly sunken, sometimes blackened and dead cankers on the twigs and branches. Affected parts turn brown and die back. *Control:* Cut out and burn diseased stems several inches below the canker. Make flush cuts just below vigorous side branches. Cut out cankers on larger branches. Dip scion and grafting tools in a ferbam or captan solution (3 tablespoons per gallon of water). Avoid wounding stems, overcrowding, overwatering, and too high a humidity. Captan, zineb, thiram, or fixed copper sprays applied just

before wet periods should prevent infections. Grow resistant varieties, e.g., Governor Moulton and Professor Sargent. Check with your nurseryman, extension horticulturist, or plant pathologist.

3. *Leaf Spots, Leaf Blight, Spot Anthracnose or Scab* — Widespread outdoors in rainy seasons. Small to large, round to irregular, yellow, brown, black, gray, purplish, or silvery spots on the leaves. Often with a distinct margin. Spots may enlarge and run together forming blotches. Infected leaves may drop early. Twigs may die back. See Figure 90. *Control:* Collect and burn infected leaves. Apply the same



Fig. 89. Camellia flower blight.

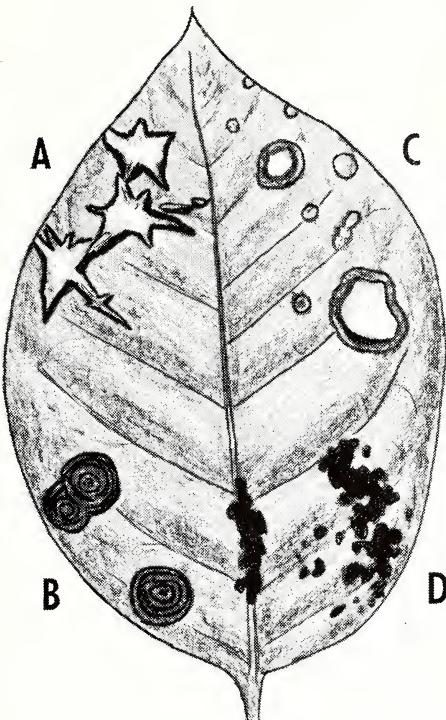


Fig. 90. Camellia leaf spots. A. Angular spot, B. Concentric spot, C. White spot, D. Black spot. All 4 types of spots would never be found on the same leaf.

fungicides as for Dieback (above). Maintain a steady, even growth with a good root system. Avoid overcrowding, overwatering, and too high a humidity. Keep the soil acid (pH 4 to pH 5.5). Avoid using too much lime.

4. *Sunscald* — Primarily an outdoor problem. Silvery to faded green or brown areas with irregular margins form on the exposed leaves. *Control:* Provide light shade and protect against strong winds.
5. *Bud Drop* — Widespread. Primarily an indoor problem. Buds turn dark and drop off. Due to unfavorable growing conditions (e.g., spring frost, severe winter freezing, high or fluctuating temperature, cold drafts, malnutrition, irregular water supply, and low air humidity). *Control:* Avoid overwatering when buds are forming. Keep the soil moisture as uniform as possible. Keep plants well supplied with nutrients. Avoid great fluctuations in temperature and soil moisture supply, cold

drafts, low light, and excessive nitrogen fertilizer. Maintain the air humidity over 50 per cent (page 28). Repot only when roots are somewhat pot-bound.

6. *Bud Rot, Bud Blight, Botrytis Flower Blight* — General. Buds and flowers rot. Often covered with a dense gray mold in wet weather. Commonly follows frost injury. *Control:* Increase the air circulation and decrease humidity. Provide a slightly warmer temperature. Space plants. Captan or zineb sprays should be beneficial.
7. *Black Mold or Mildew, Sooty Mold* — Black, moldy patches on the leaves and twigs. *Control:* Spray with malathion or lindane to control aphids and other insects. Do not use DDT on camellias — it is injurious to them.
8. *Leaf, Bud and Stem Galls, Leaf Curl* — Southeastern states. Buds and leaves are enlarged, thickened, distorted, and discolored white to reddish. May be covered with a whitish "bloom" on the underside which cracks and peels. Stems of new



Fig. 91. Camellia leaf and stem gall.
(Courtesy Dr. V. H. Young)

shoots may be thickened. See Figure 91. *Control:* Pick off and burn affected parts. Spray as for Dieback (above).

9. *Root-knot* — See (37) Root-knot under General Diseases.
10. *Infectious Leaf and Flower Variegation, Yellow Mottle* — Irregular yellow specks, blotches, or mottling on the leaves and white splotches on the flower petals. Plants off color. May die back. Plants gradually lose vigor. *Control:* Destroy plants suspected of harboring a virus or at least separate from healthy plants. Propagate only from nonvariegated plants. Applications of an iron chelate ($\frac{1}{2}$ teaspoonful per plant in a 3 gallon container every 6 to 8 weeks for 6 months) reduces virus symptoms on both leaves and flowers. The greening effect may be expected to last from 6 to 18 months. Iron sulfate may be substituted on acid soils. If plants are severely virus-infected, apply only small amounts of nitrogen fertilizer.

11. *Chlorosis* — Areas between the veins on the leaves turn yellow. See Figure 79. Leaves are curled. May be caused by a soil deficiency. *Control*: Fertilize adequately and regularly, based on a soil test. See also "Leaf and Flower Variegation" above. Soil should be kept acid (pH 4 to pH 5.5).
12. *Root Rots* — See (34) Root Rot under General Diseases. May be associated with nematodes (e.g., burrowing, dagger, lance, needle, pin, reniform, ring, root-knot, root-lesion, sheath, sheathoid, spiral, stubby-root, stylet or stunt).
13. *Crown Gall* — See (30) Crown Gall under General Diseases.
14. *Oedema* — Primarily an indoor problem. Brown, rough, corky swellings on the leaves. *Control*: Maintain a uniform soil moisture. Avoid overwatering during cloudy, humid weather. Avoid overfertilizing.

CAMOMILE — See *Chrysanthemum*

CAMPANULA — See *Bellflower*

CAMPANULATA — See *Tulip*

CAMPHOR-TREE — See *Avocado*

CAMPION — See *Carnation*

CAMPsis — See *Trumpetvine*

CAMPTOSORUS — See *Ferns*

CANARYBIRDFLOWER — See *Nasturtium*

CANAVALIA — See *Bean*

CANDLEBERRY — See *Waxmyrtle*

CANDLES OF THE LORD — See *Yucca*

CANDYTUFT — See *Cabbage*

CANNA [**EDIBLE** and **GARDEN**], **INDIAN SHOT** (*Canna*)

1. *Bacterial Bud Rot* — Widespread on young plants early in the season. Flower buds and stalks may blacken and rot. Irregular, yellowish to brown, water-soaked streaks or spots may appear on the older leaves. Irregular, thin, expanding streaks develop



Fig. 92. Bacterial bud rot of canna. Flower stalks may blacken and collapse.

along the leaves. Areas are white at first, then grayish-brown and finally black. Leaves appear ragged, spotted, or striped. May be distorted. Gummy sap may exude from blackened areas on the stalks. Flowers are ruined. See Figure 92. *Control:* Discard badly diseased plants. Soak dormant, healthy-appearing rootstocks for 2 hours in a 1:1,000 solution of mercuric chloride (see page 85 for precautions). Avoid overcrowding, overwatering, and sprinkling foliage. Increase air circulation. Destroy infected buds early. Streptomycin bud and young leaf sprays may be beneficial.

2. *Mosaic* — Irregular, light and dark green areas, or pale yellow stripes running outward from the center of the leaf to the margin. Areas may later turn a rusty-brown color. Leaves somewhat wrinkled and curled. Stems and flower parts often show yellowish bands. Plants may be stunted and late in flowering. *Control:* Destroy infected plants as they will not recover. Keep down weeds. Control aphids, which transmit the virus, using malathion. The President variety is apparently immune.
3. *Rust* — Yellowish to black powdery pustules on the lower leaf surface. *Control:* Generally not necessary. If severe, apply zineb.
4. *Tuber or Rhizome Rot, Crown Rot, Southern Blight* — See under Calla. May be associated with nematodes (e.g., burrowing).
5. *Bacterial Wilt* — See under Tomato, and (15C) Bacterial Wilt under General Diseases.
6. *Yellows* — Plants dwarfed with young leaves developing an irregular, diffuse, dull yellowing which turns bronze-colored with age. *Control:* See under Chrysanthemum.
7. *Leaf Spot* — Small spots on the leaves. *Control:* Same as for Rust (above).

CANTALOUP — See Cucumber

CANTERBURY-BELLS — See Bellflower

CAPE-COWSLIP — See Tulip

CAPE-HONEYSUCKLE — See Trumpettree

CAPE-JASMINE — See Gardenia

CAPE-MARIGOLD — See Chrysanthemum

CAPSICUM — See Tomato

CARAGANA — See Honeylocust

CARAWAY — See Celery

CARDINAL CLIMBER — See Morning-glory

CARDINALFLOWER — See Lobelia

CARDOON — See Lettuce

CARISSA — See Oleander

CAROLINA JESSAMINE — See Butterflybush

CARNATION [FLORIST'S, HARDY], GARDEN PINKS [COTTAGE, GRASS, MAIDEN, RAINBOW], SWEET-WILLIAM (*Dianthus*); CORNCOCKLE (*Agrostemma*); SANDWORT (*Arenaria*); BABYSBREATH (*Gypsophila*); MALTESE CROSS, EVENING CAMPION, RED and ROSE CAMPION, MULLEIN-PINK, JERUSALEM-CROSS, ROSE-OF-HEAVEN (*Lychnis*); HARDY GRASS PINK (*Plumaris*); CUSHION-PINK, FIRE-PINK, STARRY and MOSS CAMPION, CATCHFLY [ALPINE, SWEET-WILLIAM] (*Silene*)

1. *Fusarium Wilts, Yellows* (carnation, pinks, sweet-william) — General and serious. Plants become grayish-green, wilt, turn greenish-gray, then yellow and die gradually at high temperatures. Young shoots are often yellowed and stunted. Plants are often one-sided. Inside of lower stem may show dark brown to red streaks when split. Roots are generally healthy. Stems are softened. Root-feeding nematodes (e.g., root-knot) may increase the severity of the wilt. *Control:* Take tip cuttings only from known, disease-free plants. Plant in sterilized soil, using disease-free seed or cuttings. Cultured carnation cuttings are available. Dig up and burn infected plants as soon as found. Indoors, keep the temperature and soluble salts low. Avoid overwatering, deep planting, and injuring plants. Varieties differ in resistance.
2. *Bacterial Wilt* (carnation) — In hot weather the tops of infected plants suddenly wilt, are grayish-green, then yellowish and finally straw-colored. Inside of cut stems and roots may show yellow to brown, sticky streaks and ooze. Elongated, discolored stripes on stems which split open. Roots are rotted and sticky. Affected plants are easily pulled up. Root-feeding nematodes increase the severity of wilt. *Control:* Same as for *Fusarium Wilt* (above). Keep the potassium and calcium levels high and the phosphorus level low. Avoid splashing when watering. Plant resistant varieties.
3. *Verticillium Wilt* (carnation) — Uncommon. Symptoms much like *Fusarium Wilt*. Infected tissues turn brown. Stems are more or less solid. *Control:* Same as for *Fusarium Wilt* (above). Occurs at lower temperatures than does *Fusarium Wilt*.
4. *Alternaria Leaf Spot and Branch Rot* (carnation, Maltese cross, pinks, sweet-william) — General. Tiny purple spots on leaves and stems which later enlarge to form ash-gray to grayish-brown, dead, shrunken areas. Spots later become dark brown or black with a purple margin. Base of leaves and branches may rot, killing the parts beyond. Rotted stems are firm and dark brown in color. Most common on the lower leaves and branches. *Control:* Rotate. Destroy infected plant parts when seen and crop debris after harvest. Avoid fertilizers high in nitrogen and overcrowding. Take cuttings from the upper half of disease-free plants. Indoors, keep water off the foliage, decrease humidity, and increase the air circulation. Apply zineb, manebe, captan, dichlone, ziram, or phaltan at weekly intervals during wet periods. Start cuttings in a sterilized rooting medium.
5. *Stem and Root Rots, Southern Blight, Cutting Rot, Damping-off* — General. Plants turn pale green or yellow, wilt, then brown and die. Stems rot, often break off near the ground line without yellowing. Cuttings may develop a soft, brown, mushy rot at the base and collapse. Seedlings wilt and topple over. Roots are often discolored and rotted. May be associated with nematodes. *Control:* Same as for *Fusarium Wilt* (above). Dip cuttings in household bleach, Pano-drench, ferbam, or zineb solution before sticking. Treat sterilized soil by raking Terraclor dust into the top 2 inches of soil, or apply a soil drench of Terraclor 75 per cent wettable powder or Pano-drench. Follow the manufacturer's directions. Carnation varieties differ in resistance. Spray as for *Alternaria Leaf Spot* (above).
6. *Rusts* (babysbreath, carnation, evening campion, Maltese cross, pinks, red campion, sweet-william) — General, especially where moist. Orange, reddish-brown,

or chocolate-colored powdery pustules on leaves, stems, and buds. Plants often stunted with curled-up leaves. Varieties differ in resistance. See Figure 93. *Control:* Same as for Alternaria Leaf Spot (above), except use only zineb, maneb, ferbam and sulfur, or dichlone. Plant resistant *carnation* varieties. Dip cuttings in ferbam

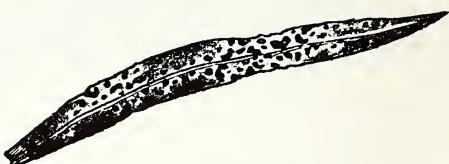


Fig. 93. Carnation rust.

solution (2 tablespoons per gallon of water plus a spreader-sticker) before planting.

7. *Mosaics, Mottle, Streak* (*carnation*, *pinks*, *sweet-william*) — Widespread. Symptoms variable. Leaves show light and dark green to yellowish-white, red, or grayish-brown spots, streaks, mottling, and flecking. Leaves may be curled and distorted. Light streaks or blotches may develop in colored flower petals of some varieties. Plant vigor, size, and flowering are often reduced. See Figure 32A under General Diseases. *Control:* Plant virus-free plants or cuttings. Destroy infected plants when first seen. By using malathion or lindane control aphids which transmit the viruses. Wash hands and cutting knife with soap and hot water before handling healthy plants.
8. *Ringspot* — Uncommon. Symptoms variable. *Carnation* and *lychnis* leaves show rings, often zoned, or a pronounced mosaic mottling with some dead flecks. *Carnation* leaf margins are wavy. Older leaves may redden and curl. In *sweet-william*, the zoned rings on the leaves turn into a general mosaic with scattered, white spots. *Control:* Same as for Mosaics (above).
9. *Curly-top* (*carnation*, *pinks*, *sweet-william*) — See under Beet, and Figure 35A under General Diseases. *Control:* Same as for Mosaics (above). Use mixture of DDT and malathion to control leafhoppers which transmit the virus.
10. *Aster Yellows* (*babysbreath*, *carnation*, *mullein-pink*, *sweet-william*) — See under *Chrysanthemum*, and (18) *Yellows* under General Diseases.
11. *Other Leaf Spots, Anthracnose, Greasy Blotch* — Small to large, pale, purplish, gray, brown, greasy, or grayish-green spots and blotches on leaves. Sometimes on stems and flowers. More common on the lower leaves which may wither and die. *Control:* Same as for Alternaria Leaf Spot (above).
12. *Gray-mold Blight, Botrytis Flower Blight* — Cosmopolitan in damp weather. Flower petals show soft, water-soaked areas which turn brown. Buds may rot and fail to open. Tops of plants may die back. A gray mold may grow on diseased areas in damp weather. Varieties differ in susceptibility. Common storage rot of flower petals and stems. *Control:* Carefully pick off and burn blighted flowers, buds, and stem tips. Apply captan, zineb, or ferbam, one to three times just before bloom. Destroy tops in the fall or after harvest. Indoors, keep water off the foliage and the humidity as low as practical. Increase air circulation and temperature. Avoid overcrowding plants. Apply a light misty spray of zineb (1 tablespoon per gallon) as the flowers are opening.
13. *Fusarium Bud Rot* — Primarily a disease of carnation. Young buds fail to open. The interior of such buds is brown or pink, moist, and decayed. A white, cottony mold and mites may also be present. White varieties are more susceptible than colored ones. *Control:* Pick off and destroy infected buds when first found. Spray with malathion to control mites which spread the causal fungus from plant to plant.

14. *Anther or Flower Smut* (*arenaria*, carnation, dianthus, Maltese cross, silene, sweet-william) — Anthers in flowers are filled with a blackish powder. Pistillate (female) flowers are aborted. Flower stalks are stunted and produce flower buds that are thick, squat, often split. Infected plants grow slowly, producing numerous secondary shoots. Appear bushy. *Control:* Destroy infected plants before buds open. Take cuttings only from healthy plants. Most modern carnation varieties are resistant.
15. *Witches'-broom, Fasciation, Leafy Gall* (babysbreath, carnation) — Fairly common but causes no serious damage. Leaves distorted and growth is stunted. See under Pea, and (28) Leafy Gall under General Diseases.
16. *Powdery Mildew* (*arenaria*, carnation) — Mealy, whitish mold growth on leaves, stems, and flowers. Varieties differ in resistance. *Control:* See under African-violet, and (7) Powdery Mildew under General Diseases.
17. *Crown Gall, Root and Stem Gall* — Soft, gall-like overgrowths at graft or soil line. Plants may be girdled, wilt, and die. *Control:* Dig up and burn affected plants. Do not propagate from infected plants. Dip newly grafted plants and grafting knives in household bleach solution (2 to 6 ounces per gallon) for 2 minutes between cuts. Carnation varieties differ in resistance.
18. *Root-knot, Cyst Nematode* — See (37) Root-knot under General Diseases.
19. *Leaf and Stem Nematode* (carnation, sweet-william) — Leaves crinkled and stems swollen. See (20) Leaf Nematode under General Diseases.
20. *Other Root-feeding Nematodes* (*criconemoides*, lance, pin, ring, root-lesion, spear, stylet) — Plants stunted. Blooming and root growth are reduced. *Control:* Plant in sterilized soil (pages 437-44).
21. *Boron Deficiency* — Tips of shoots are twisted, curled up, and may be deformed into witches'-brooms. Shoots get stuck trying to elongate. *Control:* Apply borax to soil using 1 ounce to 100 square feet. Water the borax in. Reapply as necessary. Check with your local florist or extension horticulturist.
22. *Downy Mildew* (carnation) — California. Leaves pale and curl downward. A whitish mold forms on the underleaf surface in humid weather. Plants stunted. *Control:* Same as for Alternaria Leaf Spot (above).
23. *Web Blight* — Southeastern states. See under Bean.
24. *Bacterial Leaf Spot* (carnation) — Widespread. Small, elongated, light gray leaf spots with water-soaked margins. Spots later become brown and sunken. *Control:* Same as for Bacterial Wilt (above). Spray with phenyl mercury plus a spreader-sticker.

CARNEGIEA — See Cactus

CAROLINA ALLSPICE — See Calycanthus

CAROLINA MOONSEED — See Moonseed

CARPETGRASS — See Lawnglass

CARPINUS — See Birch

CARANDA — See Oleander

CARROT (*Daucus*); PARSNIP (*Pastinaca*)

1. *Leaf Blights and Spots* — General. Outer leaves and petioles turn yellow, then brown and wither due to a tan, gray, yellowish-green, reddish-brown, or black spotting. Spots may also occur on the petioles, stems, and flower parts. Whole top may die when spots enlarge and run together. Yield is reduced. Bacterial blight may

- cause dark, scabby cankers on *carrot* roots. *Control:* Plant in well-drained soil. Keep down weeds. Three- or 4-year rotation. Burn or bury tops after harvest. Plant disease-free seed or soak *carrot* seed in hot water (122° F.) for 15 to 20 minutes. Dry seed, then dust with captan, thiram, dichlone, or chloranil. Apply maneb, zineb, ziram, or fixed copper at 7- to 10-day intervals during rainy periods.
2. *Aster Yellows* — Widespread. Younger and inner leaves are yellow, stunted, and twisted. Plants stunted, appear bunchy. Outer leaves have a bronzed, reddish, or purple color. Carrot is stunted, woody, and covered with many "hairy" roots. See Figure 34B under General Diseases. *Control:* Destroy first infected plants. Keep down weeds in and around the garden area. Spray or dust at 5-day intervals with DDT or methoxychlor and malathion to control leafhoppers which transmit the virus. Start when seedlings are 2 inches tall. Carrot varieties differ in resistance.
3. *Storage Rots, Root Canker* — Cosmopolitan. Rots of various types, some watery, slimy, foul-smelling, and wet (Bacterial Soft Rot). May be covered with a white, gray, tan, pink, blue, green, or black mold growth. Spread rapidly in damp, warm bins where roots are piled closely together. Rot may start at the crown or from a wound on the side of the root. See (29) Bacterial Soft Rot under General Diseases. *Control:* Three-year rotation. In the field, keep the nitrogen level on the low side and the potassium level high. Store roots as close to 32° F. as possible without excessive humidity (90 to 95 per cent). Dust roots lightly with thiram or captan and then store. Avoid free moisture in storage. Store only sound, blemish-free roots in layers with straw, dry leaves, or other dry filler material in between. Avoid injuries. Spray or dust in the field as for Leaf Blights (above). The storage area should be swept clean and then sprayed with copper sulfate solution (1 pound in 10 gallons of water) before storing vegetables and fruit. Do not store carrots and apples together. For information on what to store and where it should be kept, check with your extension horticulturist.
4. *Seed Rot, Damping-off* — General. Poor stand. Seeds rot. Seedlings wilt and collapse. *Control:* See under Leaf Blights (above). In addition, apply aldrin or chlordane to the soil surface before planting and immediately work into the top 3 to 6 inches. Avoid overwatering. Cultivate soil surface lightly.
5. *Root Rots* — Plants may be stunted and sickly. Roots discolored and decayed. May follow attacks by the carrot weevil, carrot rust fly, growth cracks, nematodes (e.g., dagger, lance, naccobus, reniform, rot, root-lesion, stem, stubby-root, stylet), injuries, or other diseases. *Control:* Avoid overfertilizing. Plant late. Long rotation. Control other diseases. Treat soil with chlordane or aldrin following the manufacturer's directions. See under Seed Rot (above). Harvest early. Tolerant *carrot* varieties to Violet Root Rot are Chantenay and Chantenay Red Cored. Use disease-free seed.
6. *Root-knot, Cyst Nematode* — General in southern states. Occasional in the rest of the United States. Localized areas of stunted plants. Small, gall-like swellings on roots. Taproot may be "forked," twisted, misshapen, and undersized. Yield is reduced. See Figure 50A under General Diseases. *Control:* Rotate. If serious enough, fumigate in early fall using D-D, EDB, Nemagon, Vapam, Dorlone, or Telone, following the manufacturer's directions.
7. *Watery Soft Rot, Cottony Rot, Sclerotinia Rot, Southern Blight* — Widespread. See under Bean. Occurs in patches in the field.
8. *Scab* — Dark brown areas on the root, often near the crown. *Control:* See under Beet and Potato.
9. *Parsnip Canker, Leaf Spot* — May be serious in rainy seasons. Brown to reddish, roughened surface on shoulder or crown of the root, which later turns purplish-brown to black. Whole root may decay. Small, irregular, greenish-yellow leaf spots

often with brown centers, may develop. Entire leaves may die and fall early. *Control:* Plant in well-drained soil. Keep down weeds, especially wild carrot. Apply fixed copper, bordeaux (4-2-50), maneb, or zineb at 10-day intervals, starting when leaf spots are first seen.

10. *Mosaics, Motley Dwarf, Ringspot* — Leaves mottled light to dark green and yellowed. Some rings or dead spots may appear in the leaves. Plants may be stunted with twisted petioles. *Control:* Same as for Aster Yellows (above). Control aphids which transmit the viruses. Use malathion.
11. *Curly-top* — Western states. See under Beet, and (19) Curly-top under General Diseases.
12. *Root Cracking, Boron Deficiency* — Young leaves are yellowed and malformed. Plants wilt readily. Longitudinal cracks often occur in carrot (root) when heavy rains follow a drought period, or when boron is deficient in the soil. Root may be stunted and woody. *Control:* Maintain as uniform a soil moisture as possible by watering during dry periods. Have the soil tested. If deficient in boron, apply borax as recommended by your county agent or extension horticulturist.
13. *Bacterial or Southern Wilt* — Southern states. See under Tomato, and (15C) Bacterial Wilt under General Diseases.
14. *Crown Gall* — See (30) Crown Gall under General Diseases.
15. *Downy Mildew* — Yellow spots develop on the upper leaf surface which darken with age. A yellowish mildew is found on the corresponding underside in damp weather. *Control:* Same as for Leaf Blights (above).
16. *Rust* — Small yellowish pustules on the leaves. Alternate host is bulrush (*Scirpus*). *Control:* Same as for Leaf Blights (above).
17. *Web Blight* — Southeastern states. See under Bean.
18. *Powdery Mildew* (parsnip) — See (7) Powdery Mildew under General Diseases.

CARTHAMUS — See Chrysanthemum

CARUM — See Celery

CARYA — See Walnut

CARYOPTERIS — See Lantana

CARYOTA — See Palms

CASSABA, CASSABANA — See Cucumber

CASSANDRA — See Blueberry

CASSIA — See Honeylocust

CASSIOPE — See Blueberry

CASTANOPSIS — See Chestnut

CASTILLEJA — See Snapdragon

CAST-IRON PLANT — See Aspidistra

CASTORBEAN (*Ricinus*); CHINESE TALLOWTREE (*Sapium*); QUEENS-DELIGHT (*Stillingia*)

1. *Gray-mold Blight, Botrytis Blight* — Eastern and southern states on castorbean. Occurs during humid, wet seasons. Small to large, pale brown to blackish spots on

leaves, stems, flower stalks, fruit clusters, and capsules over which a pale to olive-gray mold later grows. Blight usually occurs at blooming time. *Control:* Plant seed from disease-free castorbean plants. Where practical, carefully pick off and destroy fading flowers and infected parts. Burn tops in the fall. *Castorbean* varieties differ in resistance. Apply captan, zineb, thiram, or fixed copper one to three times, 5 to 7 days apart.

2. *Fungus Leaf Spots, Capsule Mold* — Round to irregular, white, gray, or brown spots and blotches on the leaves and capsules. Leaves and seed may wither and fall early. *Control:* Same as for Gray-mold Blight (above). Tolerant *castorbean* varieties to *Alternaria Leaf Spot*: Baker 296, Dawn, and MW-1.
3. *Bacterial Leaf Spot of Castorbean* — Southern states during rainy seasons. Brown to black, angular spots on the leaves. *Control:* Plant disease-free seed. Somewhat resistant varieties: Anjou, Baker 195, Illinois 48-36, and Western Oil Hybrid 9.
4. *Root Rots* — See under Bean, Apple, and (34) Root Rot under General Diseases. Often associated with root-feeding nematodes (e.g., burrowing, root-lesion).
5. *Root-knot* — See (37) Root-knot under General Diseases.
6. *Bacterial Wilt or Brown Rot* (*castorbean*) — Southeastern states. Plants wilt but may recover temporarily. Leaves shrivel, turn black, and drop early. Stalks and branches are blackened. *Control:* Grow plants in clean soil. Use disease-free seed.
7. *Seed Rot, Seedling Blight* — Seeds rot. Seedlings become stunted, wilt, and collapse. Leaves are blighted. *Control:* Collect and burn infected plants. Rotate. Plant in warm, well-drained, sterilized soil (pages 437-44). Spray during cool wet periods as for Gray-mold Blight (above). Treat seed with thiram, captan, or chloranil.
8. *Stem and Crown Rots, Southern Blight* (*castorbean*) — Stems discolored and rotted at or below the soil line. Plants die early. *Control:* Keep plants vigorous by fertilizing and watering. Plant in well-drained soil. Avoid overwatering and overcrowding. Keep down weeds.
9. *Verticillium Wilt* (*castorbean*) — Yellowish, then dead, areas form in the leaves between the veins. The disease progresses up the stem causing dying of the branches and blighting of the capsules. *Control:* Same as for Bacterial Wilt (above).
10. *Crown Gall* — See (30) Crown Gall under General Diseases.
11. *Seedling Red Gall* — Texas. Small red galls develop on the leaves, petioles, and stems. *Control:* Pick off and burn affected parts.
12. *Rust* (*queens-delight*) — Small yellowish spots or pustules on foliage. Alternate host is a grass (*Panicum*). *Control:* See (8) Rust under General Diseases.

**CATALPA [COMMON or SOUTHERN, JAPANESE, MANCHURIAN,
NORTHERN or WESTERN, UMBRELLA-] (*Catalpa*); DESERT-WILLOW
(*Chiropus*); JACARANDA; PODRANAEA**

1. *Leaf Spots, Anthracnose, Spot Anthracnose* — General in rainy seasons. Round to irregular, brown to black spots on the leaves. Spots may later fall out leaving holes. Leaves may wither and drop early. *Control:* Collect and burn fallen leaves. Apply three sprays, 2 weeks apart, starting as the leaves begin to unfold. Use ferbam, thiram, captan, maneb, fixed copper, or bordeaux mixture (4-4-50).
2. *Powdery Mildews* (*catalpa*) — Powdery, white mold patches on leaves. If severe, leaves may wither and drop early. *Control:* If practical, spray twice, 10 to 14 days apart, using sulfur or Karathane.
3. *Wood Rots* — Widespread. See under Birch, and (23) Wood Rot under General Diseases.

4. *Verticillium Wilt* (*catalpa*) — Widespread. The leaves on one or more branches wilt, turn brown and hang downward or fall early. Purple to bluish-brown streaks are evident in the sapwood under the bark. Affected trees may die the first year or live for many years. *Control:* See under Maple.
5. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases. May be associated with root-feeding nematodes (e.g., burrowing).
6. *Chlorosis* (*catalpa*) — See under Maple. Occurs in alkaline soils.
7. *Leaf Scorch* — Primarily in the Middle West. Follows hot, dry periods. See under Maple.
8. *Sooty Mold* — See under Elm, and (12) Sooty Mold under General Diseases.
9. *Root-knot* — See under Peach, and (37) Root-knot under General Diseases.
10. *Crown Gall* — See (30) Crown Gall under General Diseases.
11. *Dieback, Canker* — See under Apple and Maple.
12. *Seedling Blight, Damping-off* — See under Pine.

CATASETUM — See Orchids

CATCHFLY — See Carnation

CATCLAW — See Honeylocust

CATHA — See Bittersweet

CATNIP — See Salvia

CATTLEYA — See Orchids

CAULIFLOWER — See Cabbage

CAULOPHYLLUM — See Barberry

CEANOTHUS — See New Jersey-tea

CEDAR, CEDRUS — See Pine

CEDRELA — See Chinaberry

CELANDINE — See Poppy

CELASTRUS — See Bittersweet

CELERY, CELERIAC (*Apium*); **DILL** (*Anethum*);

CHERVIL (*Anthriscus* or *Chaerophyllum*); **CARAWAY** (*Carum*);

CORIANDER (*Coriandrum*); **ERYNGO, SEA HOLLY** (*Eryngium*);

FENNEL, FINOCCHIO (*Foeniculum*); **SWEET-JARVIL, ANISE-ROOT**

(*Osmorhiza*); **PARSLEY** (*Petroselinum*); **ANISE** (*Pimpinella*);

BLUE LACEFLOWER (*Trachymene* or *Didiscus*)

1. *Leaf Blights and Spots* — General, may be serious. Round to irregular, brown, yellowish-brown, ash-gray, yellow, tan, reddish-brown, or water-soaked spots on the leaves, petioles, leaf stalks and stems. If numerous, leaves may turn yellow to brownish-black, wilt, shrivel, and die. Infected seed may be discolored. Quality and yield may be reduced. See Figure 17C under General Diseases. *Control:* Plant in well-drained soil. Space plants. Keep down weeds. Do not work among wet plants. Celery varieties differ in resistance: Emerson Pascal has moderate resistance to Early and Late Blights while Giant Pascal and White Plume have moderate resistance to Late Blight. Burn or bury tops after harvest. If practical, plant rows

north and south. Plant certified, disease-free celery seed, or soak *celery* seed (also celeriac) in hot water at exactly 118° F. for 30 minutes. Dry seed and dust with thiram, captan, chloranil, or Semesan. Dust other seed with thiram or Semesan. Three-year rotation, especially of the seedbed. Apply ferbam, thiram, maneb, zineb, ziram, dichlone, Dyrene, or fixed copper sprays at 5- to 7-day intervals in the field during wet weather. Use ziram, ferbam, or thiram in the seedbed. If Bacterial Blight is a problem, add streptomycin (25 to 50 parts per million) to leaf blight sprays starting in the seedling stage.

2. *Seed Rot, Damping-off* — Cosmopolitan. Seeds rot. Poor stand. Seedlings wilt and collapse. *Control:* Treat seed as for Leaf Blights (above). Spray seedlings at 5- to 7-day intervals using ziram, ferbam, thiram, or fixed copper. Plant in sterilized soil (fumigated with chloropicrin or methyl bromide) where feasible.
3. *Fusarium Wilt, Yellows* (celery, dill, parsley) — General, except in southern states. Symptoms vary with the particular fungus strain. Plants yellowish and stunted. Growth is often one-sided. Seedlings wilt and die. Stalks brittle and have a bitter taste. Yellowish to reddish-brown or nearly black strands inside stems. Roots may decay. *Control:* Plant healthy seedlings in clean soil. Use resistant *celery* varieties in infested soil: Cornell No. 19, Easy Blanching, Emerson Pascal, Florida Golden, Forbes Golden Plume, Giant Pascal, Golden 99, Golden Pascal, Kilgore's Pride, Masterpiece, Michigan Improved Golden, Michigan State Green Gold, Pascal 284, Slow Bolting Green No. 12, Supreme Golden, Tall Golden Plume, Utah 15, and Woodruff's Beauty where adapted. Check with your extension horticulturist.
4. *Aster Yellows* — Widespread. Inner, heart leaves dwarfed, yellowed, and twisted. Whole plant may be bushy, gradually turns yellow. Petioles are upright, brittle, and commonly crack. *Control:* See under Carrot, and (18) Yellows under General Diseases.
5. *Root-knot* — Widespread. Dill is very susceptible. See (37) Root-knot under General Diseases. *Control:* Plant disease-free seed and transplants grown in clean or pasteurized soil (see "Soil Treatment Methods and Materials" in the Appendix).
6. *Stem Rot, Pink Rot, Storage Rots* — Cosmopolitan. Cut celery and parsley butts and stalks may become discolored and soft or slimy. Diseased areas may be covered with a cottony, pink, gray, bluish-green, or black mold. In the field, stems and leaf stalks suddenly wilt and collapse. A cottony mold may cover the rotted area at the ground line. See (29) Bacterial Soft Rot, and (21) Crown Rot under General Diseases. *Control:* See under Carrot. Spray as for Leaf Blights (above). Apply Terraclor (PCNB) dust or spray in the field following the manufacturer's directions.
7. *Mosaics, Calico, Yellow Spot, Motley Dwarf, Streak* — Symptoms variable. Plants often bunchy and stunted, with curled and twisted stalks. Leaves often mottled, spotted, or striped with yellow and green, crinkled, twisted, narrower than normal, cupped downward, and a sickly greenish-yellow or grayish color. Green and yellow zigzag bands and green "islands" may develop in yellow areas of the leaves (*Calico*). Leaf stalks may turn brown and shrivel. *Control:* Plant virus-free seedlings. Destroy first infected plants. Keep down weeds. Control the aphids which transmit the viruses using malathion or nicotine sulfate.
8. *Blackheart, Heart Rot* (celery, fennel, parsley) — General. Inner, heart leaves die at tips and turn dark. Later all the center leaves and petioles are affected. Outer stalks are never involved. Bacterial Soft Rot may follow. Common in low spots in the field. *Control:* Plant rows north and south in well-drained soil. Water during dry periods. Harvest promptly at maturity. Avoid overfertilization with nitrogen

(especially sodium nitrate). If practical, apply sprays of calcium chloride ($\frac{3}{4}$ to $1\frac{1}{2}$ ounces per gallon of water) or calcium nitrate ($1\frac{1}{2}$ to 3 ounces per gallon), into the heart leaves at weekly intervals, starting 5 to 7 weeks before harvest. Resistant *celery* varieties: Cornell 19, Emerson, Florida Golden, Golden Pascal, Golden Phenomenal, Salt Lake, and Winter Queen.

9. *Stem-cracking, Brown Checking, Boron Deficiency* — Occasional in all commercial celery districts where soil is heavy and alkaline. Younger and inner leaves brownish and mottled along the margins. Long, brown streaks may appear on the stems. Ragged, crosswise cracking of leaf stems. Stems (petioles) stiff, brittle, and sometimes bitter. Roots turn brown. Celery crowns are often hollow. *Control:* Have soil tested and apply borax or boric acid as recommended. Resistant *celery* varieties: Columbia No. 4130, Dwarf Golden Self Blanching, Easy Blanching No. 5178, Giant Pascal, and Golden Self Blanching. Avoid excessive use of fertilizer high in nitrogen or potassium in boron-deficient soil.
10. *Spotted Wilt* — Numerous small, yellow to orange spots on the older leaves. The spots later turn brown. Leaves may wither and die. Plants often dwarfed. *Control:* See under Tomato, and (17) Spotted Wilt under General Diseases.
11. *Curly-top* — Attacks celery, celeriac, chervil, coriander, fennel, and parsley. See under Beet, and (19) Curly-top under General Diseases.
12. *Ringspot* (celery) — Yellowish rings or spots, line or zig-zag patterns, on crinkled leaves. *Control:* Same as for Mosaics (above).
13. *Root Rots, Basal or Crown Rot* — Foliage often stunted and sickly. Roots, leaf stalk bases and crown may decay and turn red, brown, black, or bluish-green. Root-feeding nematodes may provide wounds by which rot-producing organisms enter. *Control:* Same as for Leaf Blights and Root-knot (both above).
14. *Stem Nematode* (celery, parsley) — See (20) Leaf and Stem Nematode under General Diseases.
15. *Verticillium Wilt* (celery, celeriac, parsley) — See (15B) Verticillium Wilt under General Diseases.
16. *Rust* (anise, anise-root, sweet-jarvil) — General. See (8) Rust under General Diseases.
17. *Leaf Smut, White Smut* (eryngium) — See (13) White Smut under General Diseases.
18. *Downy Mildew* — Attacks celery, chervil, fennel, and parsley. See under Carrot. *Control:* Same as for Leaf Blights (above).
19. *Bacterial Petiole Spot* (celery) — Water-soaked, sunken spots develop on the inner and outer petioles. The spots later enlarge up to an inch or so in diameter and turn yellow to deep brown. Cornell 19 and Utah 52-70 are very susceptible. *Control:* Use copper sprays to control foliage diseases. Use throughout the season. Otherwise same as for Leaf Blights (above).
20. *Root-feeding Nematodes* (awl, pin, root-lesion, sheath, sting, stubby-root, stylet or stunt) — Associated with sickly, stunted, unthrifty plants. Roots often short and stubby. Often found together with Root-knot. *Control:* Same as for Root-knot (above).

CELOSIA — See Cockscomb

CELTIS — See Hackberry

CELTUCE — See Lettuce

CENTAUREA — See Chrysanthemum

CENTIPEDEGRASS — See **Lawngrass**

CENTRANTHUS — See **Valerian**

CENTROSEMA — See **Pea**

CENTURYPLANT (*Agave*); **FURCRAEA**; **WILD TUBEROSE**,
SPICELILY (*Manfreda*)

1. *Anthracnose, Black Rot* — Round, sunken, dark spots with a raised border on the leaves. Spots may enlarge and run together causing the whole leaf to die. *Control:* Pick off and burn infected leaves. Indoors keep water off the foliage. If practical, apply copper, zineb, or maneb several times, 10 days apart, during rainy periods.
2. *Leaf Spots, Leaf Blights, or Scorch* — Spots and blotches of various colors and shapes on leaves. Spots may enlarge and cover the entire leaf. *Control:* Same as for Anthracnose. Indoors raise the temperature and maintain a uniform soil moisture.
3. *Gray-mold Blight* — See under *Begonia*. Follows overwatering or chilling. *Control:* Avoid overwatering or chilling. Space plants to increase air circulation.
4. *Root-knot* — See (37) *Root-knot* under *General Diseases*.
5. *Rust* (*manfreda*) — Small yellowish pustules on leaves. *Control:* Same as for Anthracnose (above).

CEPHALANTHUS — See **Buttonbush**

CEPHALOTAXUS — See **Japanese Plum-yew**

CERCIS — See **Honeylocust**

CEREUS — See **Cactus**

CERIMAN — See **Calla**

CHAENOMELES — See **Apple**

CHAEROPHYLLUM — See **Celery**

CHAMAECYPARIS — See **Juniper**

CHAMAEDAPHNE — See **Blueberry**

CHASTE-TREE — See **Lantana**

CHAYOTE — See **Cucumber**

CHECKERBERRY — See **Heath**

CHECKERMALLOW — See **Hollyhock**

CHEIRANTHUS — See **Cabbage**

CHELIDONIUM — See **Poppy**

CHELONE — See **Snapdragon**

CHERRY, CHERRY-LAUREL — See **Peach**

CHERVIL — See **Celery**

**CHESTNUT [AMERICAN, CHINESE, JAPANESE, SPANISH or EUROPEAN],
CHINQUAPIN (*Castanea*); GOLDEN CHINQUAPIN (*Castanopsis*)**

1. *Chestnut Blight or Canker* — General. Reddish-orange, yellowish-brown or brown, slightly sunken, cracked, girdling cankers on twigs, branches, and trunk. Blight quickly spreads down into the trunk. Leaves of affected portions suddenly turn yellow and brown, wilt, die, and hang downward on the branches. Spread by insects and birds. This disease has practically eliminated the American and Spanish or European chestnuts from the United States. *Control*: Plant the resistant Chinese and Japanese chestnuts. Resistant varieties: Alaling, Alamoore, Blackbeauty, and Ching Chow.
2. *Leaf Spots, Anthracnose* — Spots of various sizes and colors on the leaves. Not serious. Spots may drop out or enlarge and run together causing leaves to blight. *Control*: Collect and burn leaves in the fall. If practical spray as for Maple Anthracnose.
3. *Twig Blights, Cankers, Dieback* — Widespread. Discolored, sunken to swollen cankers on twigs, branches, and trunk. May girdle and kill parts beyond. Leaves on girdled branches wilt, turn brown, and die. Growth is stunted. Trees may be deformed. Most serious on young trees. *Control*: Maintain vigor by fertilizing and watering. Plant in well-drained soil where air circulation is good. Prune out and burn dead or cankered wood, making cuts at least 6 inches below any sign of infection. Avoid leaving stubs. For large cankers on the trunk contact a competent tree surgeon. Paint over wounds promptly with a good tree wound dressing. All varieties and seedlings are resistant to the common twig cankers (*Cryptodiaporthe* and *Botryosphaeria*) when grown on proper sites. Remove and burn severely diseased trees. Spray as for Leaf Spots (above).
4. *Wood Rots* — See (23) Wood Rot under General Diseases.
5. *Root Rots* — Trees decline in vigor. Foliage is thin and sickly. Leaves turn yellow, wither, and drop early. See under Apple, and (34) Root Rot under General Diseases. Most varieties and seedlings are highly resistant to *Phytophthora* Root Rot.
6. *Powdery Mildews* — Powdery, grayish-white mold growth on leaves and young shoots. If severe, leaves may turn yellow and wither. *Control*: If serious enough, spray twice, 10 days apart, using Karathane or sulfur.
7. *Oak Wilt* — See under Oak.
8. *Leaf Blister (chinquapin)* — See under Oak.
9. *Blossom-end Rot of Nuts* (Chinese chestnut) — Brown then black rot of blossom-end of fruit. Rot area often is later covered with a pale grayish mold. *Control*: Spray developing fruit with captan or zineb. Keep trees well pruned. Individual trees vary greatly in resistance.

CHICORY — See Lettuce

CHILOPUS — See Catalpa

CHINA - ASTER — See Chrysanthemum

CHINABERRY, CHINA TREE (*Melia*); CEDRELA, CHINESE CEDRELA (*Cedrela*)

1. *Leaf Spots, Downy Mildew* — General. Rarely serious. Spots of various sizes, shapes, and colors on leaves. *Control*: None usually necessary. If needed, spray several times during wet periods using zineb, maneb, or fixed copper.
2. *Twig Blight, Cankers, Limb Blight* — Twigs and branches die back. Discolored cankers may form on the twigs causing parts beyond to wilt and die. *Control*: Cut out dead and cankered twigs. If serious enough, spray as for Leaf Spots (above).

3. *Powdery Mildew* — Grayish-white mold patches on the leaves. *Control:* None usually necessary. If practical, spray once or twice, 10 days apart, using Karathane or sulfur.
4. *Black Mildew, Sooty Mold* — Black, moldy patches on the leaves following insect attacks. *Control:* Apply malathion sprays to control scales, white flies, and other insects.
5. *Wood Rots* — See (23) Wood Rot under General Diseases.
6. *Root-knot* — See under Peach, and (37) Root-knot under General Diseases.
7. *Mistletoe* — See (39) Mistletoe under General Diseases.
8. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases.
9. *Thread Blight* — Southeastern states. See under Walnut. *Control:* Spray as for Leaf Spots (above).

CHINESE BEAUTY BUSH — See **Viburnum**

CHINESE BELLFLOWER — See **Bellflower**

CHINESE BITTERSWEET — See **Bittersweet**

CHINESE CABBAGE — See **Cabbage**

CHINESE CEDRELA — See **Chinaberry**

CHINESE EVERGREEN — See **Calla**

CHINESE FORGET - ME - NOT — See **Mertensia**

CHINESE HIBISCUS — See **Hollyhock**

CHINESE HOUSES — See **Snapdragon**

CHINESE LANTERNPLANT — See **Tomato**

CHINESE PARASOLTREE — See **Phoenix - tree**

CHINESE PRIMROSE — See **Primrose**

CHINESE REDBUD, CHINESE SCHOLARTREE — See **Honeylocust**

CHINESE TALLOWTREE — See **Castorbean**

CHINESE TRUMPETCREEPER — See **Bignonia**

CHINESE WAXGOURD — See **Cucumber**

CHINESE WOLFBERRY — See **Matrimony - vine**

CHINODOXA — See **Tulip**

CHINQUAPIN — See **Chestnut**

CHIONANTHUS — See **Ash**

CHIVES — See **Onion**

CHOKEBERRY, CHRISTMASBERRY — See **Apple**

CHRISTMAS CHERRY — See **Tomato**

CHRISTMAS - ROSE — See **Delphinium**

CHRYSANTHEMUM [ANEMONE-FLOWERED, ARCTICUM, CUSHION, FLORISTS', FOOTBALL MUMS, GARLAND, HARDY, KOREAN, POMPON, and TRICOLOR], CORN-MARIGOLD, FEVERFEW, GIANT DAISY, OXEYE DAISY, PARIS DAISY or MARGUERITE, PYRETHRUM [COMMON or PAINTED DAISY, DALMATION] (*Chrysanthemum*); SNEEZEWORT, YARROW (*Achillea*); YELLOW IRONWEED (*Actinomeris*); AGERATUM, MISTFLOWER (*Ageratum*); PEARLEVERLASTING (*Anaphalis*); EVERLASTING, PUSSYTOES (*Antennaria*); CAMOMILE, GOLDEN MARGUERITE (*Anthemis*); AFRICAN DAISY (*Arctotis*); ARNICA, WORMWOOD [COMMON, MUGWORT, OLDMAN, RUSSIAN, SILVER KING], DUSTY-MILLER (*Artemisia*); ASTER [BLUE WOOD, ITALIAN, NEW ENGLAND, NEW YORK, PERENNIAL (HARDY ASTER or MICHAELMAS DAISY), ROCK, WHITE HEATH, and WHITE UPLAND] (*Aster*); BALSAMROOT (*Balsamorhiza*); ENGLISH DAISY (*Bellis*); BUR - MARIGOLD (*Bidens*); FALSE - CAMOMILE (*Boltonia*); SWAN RIVER DAISY (*Brachycome*); POT MARIGOLD (*Calendula*); CHINA - ASTER or ANNUAL ASTER (*Callistephus*); SAFFLOWER (*Carthamus*); CORNFLOWER or BACHELORS - BUTTON, BASKETFLOWER, DUSTY - MILLER, MOUNTAIN BLUET, SWEET SULTAN (*Centaurea*); GOLDEN - ASTER, ROSINWEED (*Chrysopsis*); THISTLE, PLUMED THISTLE (*Cirsium*); BLESSEDTHISTLE (*Cnicus*); TICKSEED, GOLDEN - WAVE (*Coreopsis*); COSMOS [COMMON, YELLOW] (*Cosmos*); HAWKSBEARD (*Crepis*); DAHLIA [COMMON, MINIATURE, POMPON] (*Dahlia*); CAPE MARIGOLD (*Dimorphotheca*); LEOPARDSBANE (*Doronicum*); PURPLE - CONEFLOWER or BLACK SAMSON (*Echinacea*); GLOBETHISTLE (*Echinops*); TASSELFLOWER, FLORAS - PAINTBRUSH (*Emilia*); ENCELIA; FLEABANE (*Erigeron*); BONESET, WHITE SNAKEROOT, MISTFLOWER, JOE - PYE - WEED (*Eupatorium*); BLUE DAISY (*Felicia*); GAILLARDIA, FIREWHEEL or ANNUAL BLANKET - FLOWER (*Gaillardia*); AFRICAN DAISY (*Gazania*); TRANSVAAL DAISY (*Gerbera*); SNEEZEWEEDE, YELLOW STAR (*Helenium*); SUNFLOWER [ASHY, COMMON, DARKEYE, GIANT, PRAIRIE, STIFF, THINLEAF] (*Helianthus*); STRAWFLOWER (*Helichrysum*); ORANGE SUNFLOWER, OXEYE (*Heliospisis*); INULA, ELCAMPANE (*Inula*); TIDYTIPS (*Layia*); BLAZING - STAR, GAYFEATHER, BUTTON SNAKEROOT (*Liatris*); MALACOTHRIX; FALSE - CAMOMILE or GERMAN CAMOMILE, TURFING DAISY (*Matricaria*); STEVIA (*Piqueria*); PRAIRIE - CONEFLOWER (*Ratibida*); BLACK - EYED - SUSAN, GOLDENGLOW, BROWN-EYED - SUSAN, CONEFLOWER (*Rudbeckia*); Cineraria, DUSTY - MILLER, GERMAN IVY, GROUNDSEL, PURPLE RAGWORT (*Senecio*); SILPHIUM, CUP - PLANT or INDIAN - CUP, COMPASSPLANT (*Silphium*); WIRELETTUCE (*Stephanomeria*); CORNFLOWER ASTER, STOKES - ASTER (*Stokesia*); MARIGOLD [AZTEC (AFRICAN or AMERICAN), FRENCH, GUINEA GOLD] (*Tagetes*); TANSY (*Tanacetum*); TORCH FLOWER (*Tithonia*); COLTSFOOT (*Tussilago*); CROWNBEARD (*Verbesina*); WYETHIA; ZINNIA

1. *Leaf Spots, Leaf Blight or Blotch* — General. May be serious. Spots of various shapes, sizes, and colors on the leaves. Spots may run together forming large, irregular blotches. Leaves may discolor, gradually wither, and die. Often starts at base of plant and progresses upward. Leaves may drop early or cling to the stem. Certain spots also occur on the stems and flower petals. See Figure 94. *Control:* Burn tops in the fall. Rotate. Keep down weeds. If practical, pick off and burn the first infected leaves. Apply zineb, ferbam, maneb, thiram, captan, or phaltan at 7- to 10-day intervals during wet weather. Dip cuttings in a solution of ferbam, captan, zineb, ziram, or thiram (1½ tablespoons per gallon) before sticking in the rooting medium. Soak *China-aster* seed for 30 minutes in a 1:1,000 solution of

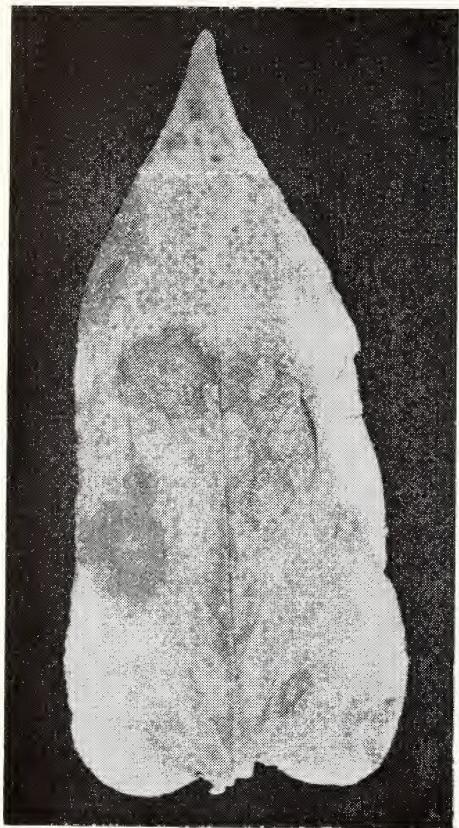


Fig. 94B. *Septoria* leaf spot and blight of chrysanthemum.

Fig. 94A. *Alternaria* blight of zinnia.

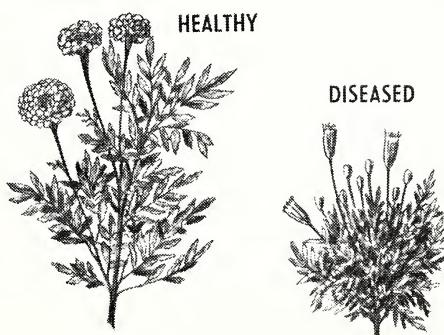


Fig. 95. Chrysanthemum powdery mildew.

mercuric chloride or Semesan (2 teaspoons per quart) then wash (after mercuric chloride treatment) thoroughly in running water for 5 minutes, dry, and plant. Soak *zinnia* seed in hot water (125° F.) for 30 minutes then dry and treat seed with captan, thiram, or chloranil. Treat other seed by dusting with captan, thiram, or chloranil. See "Seed Treatment Methods and Materials" in the Appendix. Varieties of certain plants (e.g., chrysanthemum and zinnia) differ in susceptibility. Indoors, keep water off the foliage. Do not work among wet plants.

2. *Powdery Mildews* — General. Powdery, whitish, mold patches on leaves, stems, and flower buds especially in late summer. Mostly on the lower half of infected plants. Leaves may wither and drop prematurely. Plants may be stunted, disfigured, and weakened. See Figure 21A under General Diseases and Figure 95. *Control*: Avoid overcrowding. Collect and burn tops in the fall or after harvest. Resistant varieties are available for some plants. Apply Karathane, phaltan, sulfur, or Acti-dione following the manufacturer's directions. Avoid dusting or spraying when temperatures are above 85° F.
3. *Crown, Stem and Root Rots, Southern Blight, Cutting Rot, Damping-off* — General. May be serious in wet weather. Plants often stunted and sickly. Foliage wilts and turns yellow. Plants suddenly or gradually die. May collapse. Near the soil line the stem may be water-soaked or discolored, brown, bleached white, black or covered with a cottony mold. Roots (and tuber) decayed or may rot in storage. Common on heavy, wet soils. Seedlings wilt and collapse (damp-off). See Figure 37A, (21) Crown Rot, and (34) Root Rot under General Diseases. Often associated with root-feeding nematodes. *Control*: Dig up and destroy infected plants. Take tip cuttings from vigorous, disease-free plants and plant in a sterilized rooting medium (pages 437-44). Plant in well-drained soil in a sunny location. Five-year rotation. Grow resistant varieties, if available. Avoid overcrowding, overwatering, overstimulation with fertilizer and planting in infested soil. Spot drench with Terraclor 75 per cent (PCNB) and captan 50 per cent or ferbam 76 per cent, when crown rot is first evident. See under Wirestem of Cabbage. Plant disease-free seed treated with captan, thiram, or chloranil. See Table 13 in the Appendix.
4. *Aster Yellows, Stunt* — General and serious. Symptoms variable. Leaves yellowish. Plants often stiff, stunted or dwarfed, and "bushy" with numerous, yellowish, upright, spindly shoots. Leaves are often mottled and distorted. Older leaves may

Fig. 96. Aster yellows of marigold.



be reddish. Flowers may be deformed and greenish, dwarfed, or none. Bloom may be greatly reduced, especially in future years. Infected plants never recover. See figures 34A and D under General Diseases and Figure 96. *Control*: Grow plants under fine cheesecloth (22 threads per inch), wire (18 wires per inch), or apply insecticide (e.g., DDT and malathion) at least weekly. This controls the leafhoppers which transmit the virus. Destroy the first infected plants. Keep down

all weeds within 200 feet of flower beds, if possible. Plant virus-free stock from a reputable nursery.

5. *Mosaics, Dwarf, Stunt, Leaf Curl, Rosettes* — General. A virus complex. Plants often stunted or dwarfed and "bushy" with curled, dwarfed, distorted, mottled, yellow, and light or dark green leaves. Bloom may be greatly reduced, especially in future years. Infected plants never recover. Flowers often stunted. May show streaks or develop distorted petals. Symptoms may be masked in hot weather or are never expressed in certain varieties. See (16) Mosaic, and (18) Yellows (Stunt) under General Diseases. *Control:* Remove and burn infected plants when first seen. Plant virus-free seed and transplants or propagate only from known disease-free plants. Keep down weeds. Control aphids and leafhoppers which transmit the viruses using DDT or methoxychlor and malathion.
6. *Ringspot, Oakleaf Disease* (primarily aster, calendula, China-aster, dahlia, strawflower, sunflower, and zinnia) — Irregular, pale green to bright yellow or yellowish-green spots, single or zoned rings, oakleaf or irregular zigzag markings, and other line patterns on the leaves. See Figure 33B under General Diseases. Leaves may tend to outgrow symptoms. *Control:* Same as for Mosaics (above).
7. *Spotted Wilt, Ringspot* — Symptoms variable. Pale yellow to dark green spots, ring or line patterns develop in the leaves. Leaves may later be distorted or appear bronzed, often with a slight mottling. Dead areas may appear in the leaves and stem. Young plants are commonly killed. Flowers are often dwarfed and distorted. See (17) Spotted Wilt under General Diseases. *Control:* Same as for Mosaics (above). Control thrips and aphids which transmit the virus. Use a mixture of DDT and malathion.
8. *Curly-top* — Plants "bushy" with shoot tips turning yellow. Leaflets often curled and twisted with petioles turning down. Flower buds and flowers are dwarfed. See Figure 35B. *Control:* Same as for Aster Yellows (above).
9. *Fusarium Wilt, Stem Rot* — General and serious on China-aster and marigold. Symptoms variable. Plants may wilt and gradually or suddenly wither and die at any age. Stem may be water-soaked or darkened near the soil line. Plants often stunted, yellowish, and show one-sided growth. Young plants suddenly wilt and die. See Figure 29D under General Diseases. *Control:* Grow wilt-resistant varieties of China-aster and African marigold. Plant disease-free seed or plants in clean or sterilized soil (see "Soil Treatment Methods and Materials" in the Appendix) or soak *China-aster* seed for 30 minutes in a 1:1,000 solution of mercuric chloride. Then wash thoroughly for 5 minutes in running water, dry at room temperature, and dust with thiram, chloranil, or captan. Five to 6-year rotation. Plant in well-drained, disease-free soil where wilt has not been a problem.
10. *Verticillium Wilt* — Widespread. Symptoms variable. Whole plant may be stunted with pale green to yellow leaves. Leaves wilt, wither, die, and cling to the stem, starting usually at the base. Often starts on one side of the plant. Plants may ripen prematurely. Shoot tips may be blighted. Dark streaks occur inside the lower stem. *Chrysanthemum* varieties differ in resistance. See under Bellflower, and (15B) Verticillium Wilt under General Diseases. *Control:* Dig up and burn infected plants. Otherwise same as for Fusarium Wilt (above). Cultured cuttings of chrysanthemum are available.
11. *Bacterial Wilt* — Mostly southern states or in greenhouses. Plants suddenly wilt and collapse. "Recover" at night for a few days before plants dry up and die. Usually there is a soft, wet rot inside the stem near the soil line. *Control:* Plant disease-free seed in clean or sterilized soil or cuttings from healthy plants. Dig up and burn infected plants.
12. *Rusts* — General. Small, bright orange, yellowish-orange, reddish-brown or chocolate-

Fig. 97. Chrysanthemum rust.



brown, dusty pustules mostly on the underside of leaves. Leaves may turn yellow, wither, and die. If severe, plants may be stunted. Alternate hosts may include pines, sedges, rushes, and wild grasses. See Figure 97. *Control:* If practical, pick off and burn infected leaves. Burn tops in the fall or plow them under cleanly. Take cuttings from healthy plants. Destroy alternate hosts where feasible. Indoors avoid sprinkling foliage. Keep the humidity down and increase air circulation. Apply zineb, ferbam, thiram, manebe, or sulfur at 7- to 14-day intervals during wet periods, starting in early summer. Resistant varieties of *China-aster* and possibly other plants are available. Treat *safflower* seed with Panogen 15 or Ceresan and store seed, if possible, for 1 to 2 months or longer before planting. Acti-dione (1 to 20 parts per million) as a 30-minute soak or a dichlone dust are also recommended.

13. *Gray-mold Blight, Botrytis Blight, Head or Blossom Blights, Ray Blight, Stem Blight, Bud Rot* — Cosmopolitan. Small to large, water-soaked to tan or brown spots on flower petals, leaves, buds, and stems. Stems (cuttings) may rot causing the foliage beyond to wilt, wither, and die. Affected parts may be covered with a coarse, tannish-gray mold in damp weather. Seedlings wilt and collapse. Common on fading flower heads. Flowers may be deformed, one-sided, or blasted. Buds may rot. See Figure 19D and Figure 45D under General Diseases. *Control:* Destroy fading flower heads promptly. Space plants and keep down weeds. Avoid over-watering and forcing plants too rapidly. Indoors, same as for Rusts (above). Spray buds and blooms lightly with zineb or captan. Apply manebe, zineb, ferbam, dichlone, or captan, plus wetting agent, at weekly intervals during wet weather. Spot drench with Terraclor 75 per cent (PCNB) just before planting.
14. *Stem Cankers* — Cankers form on the stem near the ground line or where branches arise. Roots and crown are usually healthy. *Control:* Keep base of plants dry. Spray as for Leaf Spots and Rusts (both above). Burn tops in the fall. Destroy infected plants when found.
15. *Root-knot* — See under Bean, and Figure 50 under General Diseases. Calendula is highly susceptible.
16. *Downy Mildews* — Widespread. Pale green or light yellow spots or mottling on the upper leaf surface with a delicate, whitish mold on corresponding underleaf surface. Leaves shrivel and die. Seedlings may wilt and die. *Control:* Same as for Gray-mold Blight (above).
17. *Leaf or Leaf Gall Nematodes* (aster, balsamroot, chrysanthemum, dahlia, groundsel, wyethia, zinnia) — Widespread and serious on chrysanthemum in wet seasons. Wedge-shaped to irregular, yellowish-brown to gray areas in leaves, bounded by the larger veins. Blotches later turn brown to black, enlarge, and run together. Leaves wither, die, and hang downward on the stem starting at the base. Plants lack vigor. May die prematurely. Flowers develop improperly. Varieties

- differ in resistance. Plants stunted in early spring with dwarfed, distorted, and crinkled leaves. See Figure 36A under General Diseases. *Control:* Take cuttings from the tips of tall, disease-free plants. Burn all tops and fallen leaves in autumn. Pick off and burn infested leaves and the two healthy-appearing leaves above, as they develop. Mulch plants to avoid splashing water on the foliage. Rotate. Do not propagate from infested clumps. Avoid overhead watering. Nurserymen soak dormant *chrysanthemum* stock plants (or "stools") in hot water (118° F.) for 15 minutes or 112° F. for 30 minutes. The treatment is often injurious.
18. *Crown Gall* — Plants stunted with spindling shoots. Large, gall-like tumors at base of plant, on the roots or both places. *Control:* See (30) Crown Gall under General Diseases. Pull up and burn affected plants.
 19. *Storage Rots* (*dahlia*) — See under Carrot. Do not dig until tubers are mature, but before frost injury occurs. Store only sound, thoroughly dried tubers in a dry, cool (40° F.) location.
 20. *White or Leaf Smuts* (*arnica*, *aster*, *boltonia*, *calendula*, *dahlia*, *fleabane*, *gaillardia*, *prairie coneflower*, *rudbeckia*, *senecio*, *silphium*, *sneezeweed*, *sunflower*) — Round to irregular, yellowish-green spots which later turn brownish to black. Spots may drop out leaving shot-holes. Leaves may drop early. See (13) White Smut under General Diseases. Indoors, keep water off the foliage.
 21. *White-rust* — Pale yellowish spots on the leaves which later turn brown. Snow-white, powdery pustules develop on the lower leaf surface. Leaves may die. Plants are often dwarfed. *Control:* Collect and burn infected plant parts and destroy all plant debris after harvest. Keep down weeds. See also (9) White-rust under General Diseases.
 22. *Fasciation, Leafy Gall* (primarily *chrysanthemum*, *dahlia*, *pquieria*, *pyrethrum*, and *Shasta daisy*) — Mass of stems, shortened and thick with cauliflowerlike growth at the soil line. Leaves aborted and misshapen. Plants dwarfed with abundant buds and distorted shoots. Clumps may rot. *Control:* See (28) Leafy Gall under General Diseases.
 23. *Bacterial Blight* (*chrysanthemum*) — Water-soaked to brown or reddish-brown, rotted spots on the stem which may extend down to the soil line. Stems may collapse. Cuttings rot at the base. *Control:* Snap off cuttings from healthy plants. Plant in sterilized soil to which streptomycin (10 parts per million) is added.
 24. *Black Mold* — Sootlike patches on the foliage. See (12) Sooty Mold under General Diseases.
 25. *Scab* (*dahlia*, *tickseed*) — See under Beet, and (14) Scab under General Diseases.
 26. *Dodder* — See Figure 53 under General Diseases.
 27. *2,4-D Injury* — See under Grape.
 28. *Other Root-feeding Nematodes* (bulb, dagger, lance, pin, ring, root-lesion or meadow, spiral, stubby-root, stylet) — Associated with stunted, sickly plants. Roots may be short, stubby, discolored and decayed. *Control:* See under Root-knot (above).
 29. *Hopperburn* (primarily *dahlia*) — See under Potato. Leaf margins are scorched. Plants may be stunted and yellowish.

CHRYSSOPSIS — See Chrysanthemum

CHUPEROSA — See Clockvine

CICHORIUM — See Lettuce

CIGARFLOWER, FIRECRACKER PLANT (*Cuphea*)

1. *Gray-mold Blight* — Occasional in greenhouses. See under Begonia, and (5) Botrytis Blight under General Diseases.
2. *Powdery Mildew* — See (7) Powdery Mildew under General Diseases.
3. *Root Rot* — See under Geranium, and (34) Root Rot under General Diseases.
4. *Root-knot* — See (37) Root-knot under General Diseases.
5. *Leaf Spot* — See (1) Fungus Leaf Spot under General Diseases.

CIMICIFUGA — See Anemone

CINCHONA — See Buttonbush

CINERARIA — See Chrysanthemum

CINNAMON - TREE (*Cinnamomum*) — See Avocado

CINNAMONVINE — See Yam

CINQUEFOIL — See Rose

CIRSIUM — See Chrysanthemum

CISSUS — See Grape

CITRON — See Cucumber

CITRUS: LEMON [PONDEROSA, MEYER, LIME], ORANGE [SOUR or SEVILLE, KING, OTAHEITE, SATSUMA, MANDARIN, COMMON or SWEET], GRAPEFRUIT, PUMMELO, TANGERINE, TANGELO (*Citrus*); KUMQUAT (*Fortunella*); HARDY or ORIENTAL ORANGE (*Poncirus*)

1. *Root Rots, Collar or Foot Rot, Tree Decline* — See under Apple, Dogwood, and (34) Root Rot under General Diseases. Seedlings may wither and die. Often associated with nematodes (e.g., burrowing, citrus, dagger, lance, reniform, ring, root-knot, root-lesion or meadow, sheath, sheathoid, spiral, sting, stubby-root). *Control:* Plant in sterilized soil (pages 437-44). Avoid overwatering. Commercial growers soak bare-rooted nursery stock in hot water (122° F.) for 10 minutes before planting.
2. *Chlorosis, Leaf Yellowing* — Leaves turn yellowish-green or remain green along the veins. May fall early. Plants stunted and sickly. See also under Gardenia. *Control:* Plant in slightly acid (pH 6.5) soil which is sterilized and well-drained. Avoid overwatering, overfertilizing, adding excess lime, and great temperature changes. Repot if roots are potbound. Control insects and mites by using malathion. Place in a sunny location.
3. *Leaf Spot, Anthracnoses, Wither Tip, Twig Blight* — General. Leaves are spotted. Shoots and twigs may wither and die back. Gum may exude from wounds. Buds may not open and often drop. *Control:* Indoors, keep water off the foliage. Keep trees growing vigorously by proper fertilization and watering, and controlling insects with malathion sprays. Pick or prune off and burn blighted parts. Outdoors, spray during rainy periods using zineb, ferbam, maneb, or captan.
4. *Sooty Molds, Sooty Blotch* — Black mold patches on leaves, twigs, and fruits following attacks by aphids, scales, mealybugs, whiteflies, and other insects. *Control:* Apply malathion sprays to control insects.
5. *Crown Gall* — See under Apple, and (30) Crown Gall under General Diseases.
6. *Other Diseases* — If grown outdoors, in citrus-growing areas, many other diseases could occur. Check with your county agent or extension plant pathologist. Excel-

lent bulletins, e.g., *Handbook of Citrus Diseases in Florida*, Florida Agricultural Experiment Station Bulletin 587, are also available.

CLADRASTIS — See Honeylocust

CLARKIA — See Fuchsia

CLEMATIS [HENRY, JACKMAN, JAPANESE], VIRGINS - BOWER (*Clematis*); YELLOWROOT, SHRUB - YELLOWROOT (*Xanthorhiza*)

1. *Leaf Spots, Leaf Blight* — Widespread. Tan, gray, reddish-brown, or brown spots of various sizes and shapes on leaves. Leaves may wither and drop early. *Control:* If practical, remove and burn infected leaves. Space vines. Plant in a new location. Apply zineb, ferbam, captan, maneb, thiram, or fixed copper at 7- to 10-day intervals during wet weather.
2. *Stem Rot, Wilt* (*clematis*) — Foliage wilts, withers, and dies from a girdling dark canker on the stem near the soil line. Roots may decay. *Control:* Same as for Leaf Spots. Plant in well-drained soil. Drench soil with zineb or thiram (2 tablespoons per gallon) when disease is first noticed. Repeat weekly for a month.
3. *Powdery Mildews* — Widespread. Powdery, white mold growth on clematis foliage. Sometimes on flower petals. Large-flowered varieties appear more susceptible. *Control:* Spray two or three times using Karathane.
4. *Root-knot* — Clematis is very susceptible. Plants are stunted and sickly with small galls formed on the roots. *Control:* Plant disease-free plants in clean or sterilized soil (pages 437-44).
5. *Rusts* (*clematis*) — Small, yellowish spots on leaves. Alternate hosts include many native grasses. *Control:* Same as for Leaf Spots (above).
6. *Crown Gall* (*clematis*) — See (30) Crown Gall under General Diseases.
7. *Mosaic* (*clematis*) — See (16) Mosaic under General Diseases.
8. *Smut* (*clematis*) — See (11) Smut under General Diseases.
9. *Other Root-feeding Nematodes* (e.g., dagger, root-lesion, spiral, stylet or stunt). Often associated with sickly, stunted plants. *Control:* Same as for Root-knot (above).

CLEOME — See Spiderflower

CLERODENDRON — See Lantana

CLETHRA — See Sweet - pepperbush

CLIFFGREEN — See Bittersweet

CLIFTONIA — See Buckwheat-tree

CLIMBING MIGNONETTE — See Lythrum

CLINOPodium — See Salvia

CLITORIA — See Pea

CLOCKVINE (*Thunbergia*); CHUPEROSA (*Boloperone*); DYSCHORISTE; ERANTHEMUM; RUELLIA; SANCHEZIA

1. *Leaf Spots* — Spots of various sizes, shapes, and colors on the leaves. *Control:* Pick off and burn spotted leaves. If practical, spray during rainy periods using ferbam or zineb.
2. *Rusts* (chuperosa, dyschoriste, ruellia) — Yellow, orange-yellow, reddish-brown or black, powdery pustules on the leaves. *Control:* Same as for Leaf Spots.

3. *Crown Gall* — Rough, swollen galls form at or near the soil line. See (30) Crown Gall under General Diseases.
4. *Oedema* (*eranthemum*) — Indoor problem. "Sandy," rust-colored, swollen spots. Mostly on the upper leaf surface. *Control:* Avoid overwatering in overcast, damp weather. Increase air circulation.
5. *Root-knot* — See (37) Root-knot under General Diseases.
6. *Aster Yellows* — See (18) Aster Yellows under General Diseases.
7. *Root Rot* — See (34) Root Rot under General Diseases. May be associated with root-feeding nematodes (e.g., burrowing).

CLOUDBERRY — See **Raspberry**

CNICUS — See **Chrysanthemum**

COCCULUS — See **Moonseed**

COCHLEARIA — See **Cabbage**

COCKSCOMB (*Celosia*); **GLOBE-AMARANTH** (*Gomphrena*); **AMARANTH**, **LOVE-LIES-BLEEDING**, **JOSEPHSCOAT**, **PRINCESFEATHER** (*Amaranthus*); **ALTERNANTHERA**; **BLOODLEAF** (*Iresine*); **FROELICHIA**

1. *Seed Rot, Damping-off, Blight* — Seeds rot. Seedlings wilt and collapse from water-soaked, blackish-brown spots or rot near the soil line. Older plants show rusty-brown, zoned spots on the leaves, petioles, and stems. Spots dry out and become cankers. *Control:* See under Beet. Pull up and burn badly infected plants. Avoid overwatering. Rotate or plant in sterilized soil (see pages 437-44).
2. *Leaf Spots, Leaf Blight* — Spots of various sizes, shapes, and colors on the leaves. Leaves may curl up and fall early. *Control:* See under Chrysanthemum.
3. *Curly-top, Yellows* — See under Beet, and (18) Yellows and (19) Curly-top under General Diseases. Plants are stunted and yellowed.
4. *Root-knot* — See (37) Root-knot under General Diseases.
5. *White-rust* (*amaranth*, *froelichia*, *globe-amaranth*) — White, powdery spots on the leaves which turn reddish-brown at maturity. Flowers and stems may be stunted and distorted. *Control:* See under Chrysanthemum.
6. *Leaf Roll* (*cockscomb*, *amaranth*) — See under Potato.
7. *Black Ringspot* (*cockscomb*) — See under Cabbage.
8. *Root and Crown Rots* (*alternanthera*, *bloodleaf*, *cockscomb*) — Cuttings and young plants are stunted, often wilt and die. Roots and crowns are decayed. *Control:* Plant in sterilized soil, or treat the soil with Terraclor (PCNB) before planting.
9. *Fusarium Wilt* (*alternanthera*) — See under Chrysanthemum.
10. *Inflorescence Smut* (*bloodleaf*) — See (11) Smut under General Diseases.
11. *Blossom Blight* (*amaranth*) — See (31) Flower Blight under General Diseases.
12. *Other Root-feeding Nematodes* (e.g., pin, root-lesion, spiral) — Associated with sickly, stunted plants. *Control:* Same as for Root-knot (above).

COCONUT (*Cocos*) — See **Palms**

CODIAEUM — See **Croton**

COFFEEBERRY — See **Buckthorn**

COLCHICUM, AUTUMN-CROCUS (*Colchicum*); **CAMASS** (*Camassia*)

1. *Smut* — Small, swollen "blisters" (spots or stripes) on leaves, corms, stems, and flowers. Blisters are filled with black, powdery masses. Varieties differ in resistance. *Control:* Pick off and burn affected plant parts before blisters break open.

2. *Corm (Bulb) Rots* — See under Tulip. Corms rot in the field or storage.
3. *Botrytis Leaf Spot and Tip Blight* — See under Tulip, and (5) Botrytis Blight under General Diseases.
4. *Leaf Spot* — Small spots on the leaves. *Control:* Same as for Botrytis Leaf Spot.

COLEUS — See Salvia

COLLINSIA — See Snapdragon

COLLOMIA — See Phlox

COLTSFOOT — See Chrysanthemum

COLUMbine — See Delphinium

COLUMBO — See Gentian

COLUTEA — See Honeylocust

COMMELINA — See Tradescantia

COMPASSPLANT — See Chrysanthemum

COMPTONIA — See Sweetfern

CONEFLOWER — See Chrysanthemum

CONFEDERATE - JASMINE — See Oleander

CONVALLARIA — See Lily

CONVOLVULUS — See Morning - glory

COOPERIA — See Daffodil

COPPERLEAF — See Acalypha

COPPER - TIP — See Gladiolus

COPTIS — See Delphinium

CORALBEAN, CORAL - TREE — See Honeylocust

CORALBELLS — See Hydrangea

CORALBERRY — See Snowberry

CORDYLINE — See Dracaena

COREOPSIS — See Chrysanthemum

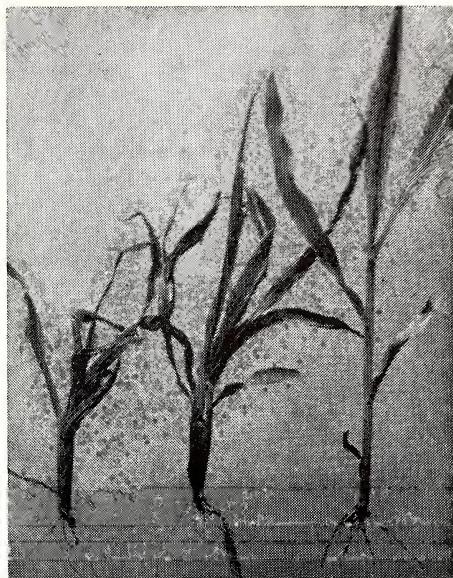
CORIANDER (*Cordiandrum*) — See Celery

CORONILLA — See Pea

CORN [BROOM, ORNAMENTAL or INDIAN, POP, SWEET] (*Zea*)

1. *Bacterial Wilt, Stewart's Disease* — General. May be serious. Most severe in northern states following *mild* winters. Long, yellowish or pale green streaks or spots in leaves which later turn brown. Seedlings or older plants often stunted, wilt, and die. Plants often tassel prematurely. Leaves dry out and appear as if frosted. Sweet corn and popcorn are quite susceptible. See Figure 31A under General

Fig. 98. Bacterial wilt of corn.



Diseases and Figure 98. *Control:* Plant disease-free seed. Spray with DDT or diel-drin at regular intervals, starting when the corn emerges, to control flea beetles which transmit the wilt-producing bacterium. Check with your county agent or extension entomologist regarding timing of sprays for your area. More or less tolerant *sweet corn* varieties: Calumet, Carmelcross, Country Gentleman W-R, Early Gold Crest, F-M Cross, Golden Beauty, Golden Cross W-R, Golden 22, 25, 50, etc., Golden Harvest, Golden Pirate, Goldrush, Honeycross, Ioana, Iochief, Mar-cross, Seneca, Seneca Dawn, Tendermost, and many more. Somewhat resistant *popcorn* varieties: South American and Sunburst.

2. *Smuts* — General, especially following hail or insect injury. Small to large, silvery-white galls or "boils" on tassel, ears, husks, leaves, prop roots, or stalk. Membrane breaks releasing dark brown to black, sooty masses. Stalks may be barren. Sweet corn is very susceptible. See Figure 25A under General Diseases. *Control:* Cut out and burn galls before they break open. Rotate. Control insects (e.g., corn earworm and European corn borer) by DDT sprays. Check with your county agent for correct timing. Partially resistant *sweet corn* varieties: Asgrow Golden 60, Country Gentleman, Evertender, Giant Bantam Hybrid, Golden Cross Bantam Hybrid, Golden Hybrid 2057, Ioana, Iochief, Mellow Gold, Pennlewis, Prospector, Seneca Brave, Tenderblonde, and Victory Golden. Differences also exist between *popcorn* hybrids.
3. *Root and Stalk Rots* — General. Plants often lean, break, or blow over. May die prematurely. Plants may be stunted, lack vigor. Stalks weak, rotted internally at base. Both fine and larger roots decay. Often associated with nematodes. When severe, plants may wither and die prematurely, producing poorly filled or nubbin ears. Excessive nitrogen fertilizer increases stalk breakage. See Figure 99. *Control:* Treat seed as for Seed Rot (below). Plant in fertile, well-drained soil. Maintain balanced soil fertility which is based on a soil test. Avoid excessively deep and close cultivations. Use locally adapted, resistant hybrids whenever available. Control soil insects, using aldrin, chlordane, dieldrin, or heptachlor. Apply to the

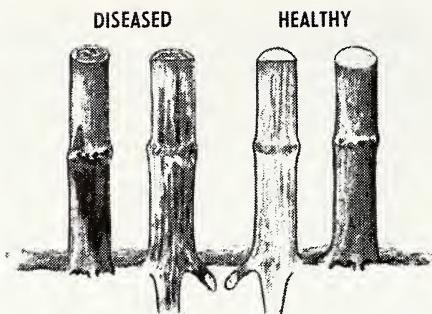


Fig. 99. Stalk rot of corn.

soil surface before planting and work into the top 6 inches. Follow the manufacturer's instructions. Repeat every 4 years.

4. *Ear and Kernel Rots* — Cosmopolitan. Ears and husks may be completely rotted and discolored white, gray, blue, pink to reddish, or black. Plants may be stunted. Often associated with Root and Stalk Rots. Rotted shanks and ears may break over early. *Control:* Same as for Root and Stalk Rots (above). In addition, handle carefully at harvest. Control corn earworms by DDT sprayed into the silks. Check with your county agent or extension entomologist.
5. *Seed Rot, Seedling Blights* — General. Seeds rot. Stand is poor, especially during cold, wet weather. Growth is uneven. Seedlings are yellow, stunted, may wilt and die. *Control:* Plant seed treated with captan, thiram, chloranil, or dichlone plus an insecticide (e.g., dieldrin or lindane). See Table 13 in the Appendix. Plant mature, high-quality, crack-free seed in warm, well-drained soil. Treat for soil insects as given under Root and Stalk Rots (above).
6. *Helminthosporium Leaf Blights* — Widespread. Small to large, grayish-green to tan or brown spots (often elliptically-shaped) on the lower leaves from midsummer on. Later the upper leaves may become infected. Plants often appear as if suf-

Fig. 100. *Helminthosporium* (northern) leaf blight of corn.

fering from drought or frost. See Figure 100. *Control:* Hybrids show differences. Often practical to spray sweet corn in very humid areas (e.g., the Gulf Coast), using zineb or maneb plus a spreader-sticker at about weekly intervals. Thorough coverage is essential. Plant early, using disease-free seed. Treat seed as for Seed Rot (above). Three-year rotation. Burn or bury deeply all plant debris after harvest. Avoid overhead sprinkling and poorly drained soil. *Sweet corn* varieties differ in resistance.

7. *Leaf Rusts* — General. Small, yellow-orange to reddish-brown or cinnamon-brown, powdery pustules on the leaves which finally turn black in color. If numerous, leaves may die early. Alternate host of Common Corn Rust is wood sorrel (*Oxalis*). *Sweet corn* varieties differ in resistance. *Control:* None usually needed. Spraying as for *Helminthosporium Leaf Blights* may be beneficial. Resistant *sweet corn* varieties: Country Gentleman and Crosby. *Popcorn* is usually resistant.
8. *Bacterial Leaf Blights and Stalk Rot* — Small, tan to dark brown spots to long narrow stripes on leaves following showery weather. Spots may run together to form irregular blotches. Stalk may suddenly rot and collapse. *Control:* None usually necessary. Seed treatment as for Seed Rot (above). Hybrids offer some hope.

Fig. 101. Crazy top of corn.



9. *Crazy Top* — Uncommon. Tassel composed of a large mass of short leaves. Plants are stunted, tiller excessively, and have narrow leaves. Stalks are barren. See Figure 101. *Control:* Avoid planting in low, wet spots which are likely to be flooded after seeding. Or drain such areas.
10. *Black Bundle* — Stalks and leaves are reddish-purple. Stalks often barren or produce small, poorly-filled ears. Black streaks inside stalk. Plants often tiller excessively. *Control:* None known.
11. *Minor Leaf Spots* — Mostly southern states. Small, round to elongate, light green, gray, tan to yellow or dark brown spots, blotches, or streaks on leaves and leaf sheaths. Spots may run together forming irregular blotches. Infected stalks break easily. *Control:* Same as for *Helminthosporium Leaf Blights* (above).
12. *Purple Sheath Spot* — Irregular, purple blotches on leaf sheaths. *Control:* Hybrids and varieties differ in resistance.
13. *Sweet Corn Mosaics and False-stripe, Leaf Fleck, Corn Stunt* — Many small, broken, yellowish or bleached flecks, spots, and streaks on leaves parallel with the veins. Plants may be dwarfed, pale yellow; leaves split. Others show new leaves almost free of stripes. *Control:* None known. Resistant hybrids may be available in the future. Aphids or leafhoppers may transmit the viruses.

14. *Stunt* — Plants stunted and bushy with yellowish-white and green leaves with a broad, bronze-red band running the length of the leaves. Many secondary shoots are formed in the axils of leaves. Virus is spread by leafhoppers. *Control:* None known.
15. *Witchweed (Striga)* — Southeastern United States in light, sandy soils. Caused by a small, parasitic flowering plant (*Striga*). Corn plants are severely stunted, yellowed. Wilt severely. Eventually the leaves turn brown and the plant dies. *Striga* feeds on the roots of corn and related grassy plants. Witchweed plants rarely grow over 8 to 9 inches tall, with brick-red, yellowish-red, yellow or white flowers. The leaves are light to dark green and slightly hairy. *Control:* If you suspect Witchweed, check with your county agent, extension weed specialist, or plant pathologist. Apply 2,4-D, where practical, before plants produce seeds. Fenac, a new preplanting herbicide, may be recommended.
16. *Root Nematodes* (awl, burrowing, dagger, lance, needle, pin, reniform, ring, root-lesion or meadow, sheath, sting, stubby-root, stylet or stunt) — Most serious in southern states. Symptoms variable. Plants may be stunted and unthrifty. Do not respond normally to water and fertilization. Often discolored and may be confused with one or more deficiency diseases. Roots often stunted (stubby), may be "bushy," show dark spots, witches'-brooms, or galls.
17. *Chlorosis* — Deficiency of magnesium, manganese, zinc, or copper. See pages 17-18.

CORNCOCKLE — See Carnation

CORNEL, CORNELIAN CHERRY — See Dogwood

**CORNFLOWER, CORNFLOWER ASTER, CORN-MARIGOLD —
See Chrysanthemum**

CORNSALAD — See Valerian

CORNUS — See Dogwood

CORYDALIS — See Bleedingheart

CORYLUS — See Birch

COSMOS — See Chrysanthemum

COTINUS — See Sumac

COTONEASTER — See Apple

COTTON - ROSE — See Hollyhock

COTTONWOOD — See Poplar

COWSLIP — See Primrose

CRABAPPLE — See Apple

CRAMBE — See Cabbage

CRANBERRY, CRANBERRY - BUSH — See Viburnum

**CRANESBILL, GERANIUM [BLOOD - RED, CAROLINA, SPOTTED or WILD],
HERB ROBERT or RED - ROBIN (*Geranium*); HERONSBILL (*Erodium*)**

1. *Fungus Leaf Spots* — Spots of various sizes, shapes, and colors on leaves. *Control:* Pick off and destroy spotted leaves. If serious enough, spray several times, 10 to 14 days apart, during wet periods. Use captan, zineb, or maneb.

2. *Bacterial Leaf Spots* — Small, round to angular, reddish-brown to black spots with colorless or water-soaked borders form on leaves. Centers of spots later turn dry and resemble "frog-eyes." Young leaves may wither and drop off. Petioles may also be spotted. *Control:* Pick off and burn infected leaves. Where practical, keep water off the leaves. Space plants.
3. *Mosaic* (geranium) — Plants stunted with mottled and distorted leaves. *Control:* Destroy infected plants when first seen. Keep down weeds. Spray or dust to control aphids which transmit the virus. Use lindane or malathion.
4. *Rusts* (geranium) — See under Chrysanthemum. Alternate host: *Polygonum* spp. or none.
5. *Downy Mildew* — Widespread. See (6) Downy Mildew under General Diseases.
6. *Botrytis Leaf Spot, Stem Rot* — See (5) Botrytis Blight under General Diseases.
7. *Stem, Crown, Root and Rhizome Rots* — See Root Rot under Geranium. May be associated with root-feeding nematodes (e.g., lance, pin, root-knot, root-lesion, spiral, stem, stubby-root, stylet or stunt).
8. *Aster Yellows* (heronsbill) — See (18) Yellows under General Diseases.
9. *Curly-top* (heronsbill) — See (19) Curly-top under General Diseases.
10. *Powdery Mildews* (geranium) — See (7) Powdery Mildew under General Diseases.
11. *Root-knot* — See (37) Root-knot under General Diseases.

CRAPE-JASMINE — See Oleander**CRAPEMYRTLE (*Lagerstroemia*)**

1. *Powdery Mildews* — Widespread and serious during spring and fall. Leaves and young shoots may be heavily coated with a powdery, white mold. Shoots, leaves, and flowers may later be distorted and stunted. Flower buds may not open. Infected leaves and buds often drop early. *Control:* Apply Karathane, phaltan, or sulfur at 10-day intervals until mildew is checked. Or use Acti-dione following the manufacturer's directions. Start when mildew is first seen. Another control is to apply lime-sulfur (diluted 1 to 80 with water) as the buds break open. Repeat two weeks later.
2. *Leaf Spots, Black Spot, Tip Blight* — Leaves spotted. If severe, leaves may wither and drop early. *Control:* If practical, apply two or three sprays or dusts of zineb or maneb 10 days apart.
3. *Sooty Mold* — Black, sootlike blotches on foliage following attacks by aphids or scale insects. *Control:* Apply malathion to control insects.
4. *Root Rot* — See (34) Root Rot under General Diseases.
5. *Chlorosis* — Plants sickly and yellowish. *Control:* Fertilize plants adequately. Be sure soil is not too acid or alkaline, but near neutral (pH 6.5 to pH 7.2).
6. *Thread Blight* — Southeastern states. See under Walnut. Plants may be defoliated early.
7. *Root-knot* — See (37) Root-knot under General Diseases.

CRASSULA — See Sedum**CRATAEGUS — See Apple****CREEPING CHARLIE — See Primrose****CREEPING MINT, CREEPING THYME — See Salvia****CREPIS — See Chrysanthemum**

CRESS — See Cabbage

CRIMSON DAISY — See Chrysanthemum

CRINUM — See Daffodil

CROCANTHEMUM — See Sunrose

CROCOSMIA, CROCUS — See Gladiolus

CROSSVINE — See Bignonia

CROTALARIA — See Pea

CROTON (*Codiaeum*)

1. *Anthracnose, Leaf and Stem Spot* — Widespread. Yellowish-gray leaf spots which later turn whitish and dry out. *Control:* Keep water off the foliage. Apply zineb or captan sprays before wet periods.
2. *Root Rot* — See (34) Root Rot under General Diseases. May be associated with nematodes (e.g., reniform).

CROWFOOT — See Delphinium

CROWNBEARD — See Chrysanthemum

CROWN IMPERIAL — See Tulip

CROWN - OF - THORNS — See Poinsettia

CROWNVETCH — See Pea

CRYOPHYTUM — See Iceplant

CRYPTOGRAMMA — See Ferns

CRYPTOMERIA — See Juniper

CUCUMBER [COMMON and ENGLISH FORCING],

MUSKMELON, CANTALOUP, HONEYDEW MELON, CASSABA,

WINTER MELON, WEST INDIAN GHERKIN (*Cucumis*);

CHINESE WAXGOURD (*Benincasa*); BRYONOPSIS; WATERMELON,

CITRON (*Citrullus*); SQUASH [SUMMER or BUSH, WINTER],

PUMPKIN [WINTER CROOKNECK or CUSHAW, COMMON],

VEGETABLE-MARROW (*Cucurbita*); GOURDS, CALABASH,

**VEGETABLE SPONGE, GUINEA BEAN, NEW GUINEA BEAN (*Cucurbita*,
Lagenaria, *Luffa*, and *Trichosanthes*); MOCK - CUCUMBER (*Echinocystis*);**

MELOTHRIA; BALSAM-APPLE, BALSAM-PEAR (*Momordica*);

CHAYOTE (*Sechium*); CURUBA, CASSABANA (*Sicana*)

1. *Anthracnose* (squashes and pumpkins almost immune) — General in warm, humid areas. Often destructive. Round to angular, reddish-brown to almost black spots on leaves. Spots may later dry and tear out with leaves withering. Light brown to black, elongated streaks on stems and petioles. Young fruit may blacken, shrivel, and drop off. Older fruits have small to large, round, sunken spots which are water-soaked at first and later dark green to black, with flesh-colored, oozing centers. Bacterial Soft Rot often follows. *Control:* Plant western-grown, disease-free seed or soak seed for 5 minutes in a warm (60° to 80° F.), 1:1,000 solution of mercuric chloride. See pages 85 or 427 for precautions. Wash seed 5 minutes in

running water, dry, and dust with captan, thiram, chloranil, or Semesan plus dieldrin or lindane. See Table 13 in the Appendix. *Cucumber* seed can be soaked in hot water (122° F.) for 20 minutes as a substitute. Dry and dust as for the mercuric chloride treatment. Plow under or burn crop debris after harvest. Keep down weeds. Three-year rotation. Plant in well-drained soil. Apply captan, zineb, thiram, or maneb at 7- to 14-day intervals, starting about when vines "start to run." Use ziram or captan on young plants. Normally resistant *watermelon* varieties: Blackstone, Black Kleckley, Charleston Gray, Congo, Dunbarton, Early Resistant Queen, Fairfax, Garrisonian, Hope Diamond, and Spaulding. Tolerant *cucumber* varieties: Ashe, Ashley, Fletcher, Palmetto, Santee, and Stono.

2. *Scab, Spot Rot, Pox* — Primarily a disease of cucumber, muskmelon, summer squash, pumpkin, watermelon, and gherkin. General in moist areas. Small, angular, water-soaked or pale green spots on the leaves which later turn white to gray. Spots tear away leaving ragged holes. Similar elongated spots occur on the petioles and stems. Small, gray, slightly sunken, oozing, gummy spots on fruit increase in size and become sunken, dark cavities lined with a dark olive-green mold. Fruit are often later destroyed by Bacterial Soft Rot. See Figure 28D under General Diseases. *Control:* Same as for Anthracnose (above), except for resistant varieties. Resistant *cucumbers*: Ashe, Dark Green Slicer, Fletcher, Highmoor, Hybrid Long Green, Hycrop Hybrid Pickling, Improved Highmoor, Maine No. 2, Nappa 63, Wisconsin SMR-9, SMR-12, SMR-15, and SMR-18.
3. *Leaf Spots, Leaf Blights* (often serious on muskmelon) — General. Small, round to irregular, water-soaked, yellow, tan, gray, brown, or black spots on leaves. Spots may enlarge, turn dark brown, and become zoned (target spots). See Figure 102. Center leaves may wither and fall early. Fruit may sunburn and ripen prematurely. Most serious in warm, moist weather. Spots may also occur on the petioles, stems, and fruit. *Control:* Same as for Anthracnose (above). Keep plants growing vigorously by fertilizing and watering. Normally resistant *muskmelon* varieties: Edisto, Hales Best 936, and Purdue 44.
4. *Angular Leaf Spot, Bacterial Spot* (primarily cucumber, muskmelon, gourds, squash, West Indian gherkin, and bryonopsis) — General. Small, angular, water-soaked spots on the leaves which later dry, turn gray, and drop out. Leaves ragged. Similar spots may occur on the stems and petioles. Round, water-soaked spots on the fruit. Fruit drop often follows. A whitish crust may develop on the surface of leaf, stem, and fruit spots. Disease is favored by frequent summer rains. *Control:* Treat seed as for Anthracnose (above). Two-year rotation. Apply a mixture of zineb or maneb (1 tablespoon) and fixed copper (1½ tablespoons per gallon), at 5- to 7-day intervals, during warm (75° F.), wet weather, starting when plants start to vine. Streptomycin sprays in the field are also effective. Destroy plant debris after harvest. Do not work among wet plants. Control insects with methoxychlor or dieldrin and malathion. Watermelon, muskmelon, and squash varieties differ in resistance. Santee *cucumber* has fair resistance. If Anthracnose or Scab is present, alternate copper with maneb or captan.
5. *Bacterial Wilt* (primarily cucumber, muskmelon, squash, gherkin, pumpkin, and gourds) — General and serious. Vines rapidly wilt, wither, and die starting with one or a few leaves on one vine. Juice from cut stems may be milky or sticky and stringy. *Squash* vines are dwarfed. See Figure 31B under General Diseases. *Watermelon* is almost immune. *Control:* Rotate. Control cucumber beetles and other insects which transmit the causal bacteria. Use dieldrin or methoxychlor at 5- to 7-day intervals before blooming and malathion at 5-day intervals after blooming. Start as plants crack soil. For a few plants in the garden, protect by starting under

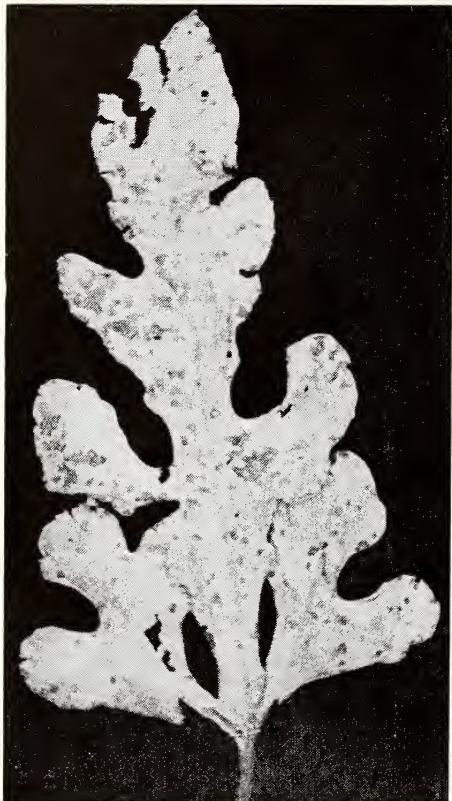
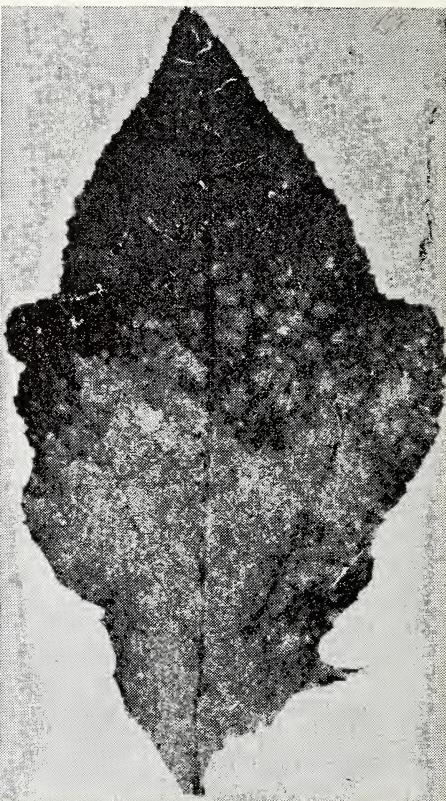


Fig. 102. Watermelon leaf spot.

Fig. 103. Powdery mildew of squash.
(Iowa State University photo)

Hotkaps and then enclosing in cheesecloth tents to keep out insects. Pull up and destroy wilted plants. Resistant *cucumber* varieties: certain pickling strains. Fairly resistant *squash*: Boston Marrow, Buttercup, Butternut, Delicious, Early Market, Mammoth Chili, Table Queen or Acorn, and Warren.

6. *Fusarium Wilt, Fruit Rots* (primarily watermelon, citron, muskmelon, cucumber, and mock-cucumber) — General in warm areas. Plants stunted and often yellow. Leaves suddenly wilt, wither, and runners gradually die. Yellow to dark brown streaks inside stems when cut. Cantaloup fruit show sunken, irregular spots. Seeds may rot in the soil. Seedlings often wilt and collapse. Roots gradually decay. See Figure 29C under General Diseases. *Control:* Treat seed as for Anthracnose (above). Sanitation. Resistant *watermelons*, where adapted: Baby Kleckley, Black-lee, Blue Ribbon, Bush Desert King, Calhoun, Charleston Gray, Charleston Gray 133, Congo, Crisscross (Chris cross), Dixie Hybrid, Dixie Queen W.R., Early Resistant Queen, Fairfax, Georgia W-R, Harper Hybrid, Hawkle, Hope Diamond, Iowa King, Improved Kleckley Sweet No. 6, Improved Stone Mountain No. 5 and 19, Klondike R-7, Klondike RS-57, Leesburg, Queen Hybrid, Shipper, Spaulding, Summit, and White Hope. Resistant *muskmelons*: Delicious 51, Early Market Hybrid, Golden Honey, Harper Market, Harvest Queen, Honey Rock, Iroquois, Minnesota Midget, Minnesota Honey, Queen of Colorado, Spartan Rock, and

Supermarket Hybrid. The Persian Honeydew, Honeyball, and Cassaba melons are also relatively resistant. Control nematodes. See Root-knot (below). Keep plants growing vigorously by fertilizing and watering.

7. *Mosaics* — General and serious. Yellow-green and dark green mottling or distortion of leaves. Leaves often stunted and curled. Vines stunted, may be yellowed and "bunchy." Fruits often show yellow, yellow-green, or pale green spotting and mottling. May be warty or knobby with a bitter taste. *Squash* fruit may also show rings. If severe, all leaves except those at runner tips (rosettes) may die. Yield is reduced. *Control*: Rigidly control weeds (e.g., bur and wild cucumber, catnip, horsenettle, milkweed, motherwort, pokeweed, white cockle, wild groundcherry, and many others). Destroy first infected plants after first applying malathion. Control aphids and cucumber beetles which transmit the viruses. Use malathion and methoxychlor at 5-day intervals. Plant virus-free *muskemelon* and *squash* seed. Resistant *cucumber* varieties: Burpee Hybrid, Challenger, Challenger Hybrid, Early Surecrop Hybrid, Hybrid Long Green, Hycrop Hybrid Pickling, Jet, Nappa 61, Ohio MR-17, MR-25, MR-200, Puerto Rico 10 and 27, Resistant Burpee Hybrid, Sensation Hybrid, Surecrop, Tablegreen, Total Marketeer, Vaughan's Hybrid, Wisconsin SMR-9, SMR-12, SMR-15, and SMR-18. Resistant *muskemelons* may be available soon. Zucchini *squash* has tolerance.
8. *Powdery Mildew* — General. May be destructive. White or brownish mealy growth mostly on the upper side of leaves and young stems. See Figure 103. Occasionally on muskmelon and watermelon fruit. Leaves and young stems may wither and die. Plants are weakened or stunted. Fruit may sunscald or ripen prematurely. *Control*: Keep down weeds. Apply Karathane or fixed copper, one to three times, 7 to 10 days apart, depending on the severity. Start when mildew is first seen. Resistant *muskemelons*: Desert Sun, Edisto, Georgia 47, Gold Cup, Golden Gate 45, Hale's Best Powdery Mildew Resistant 45, Homegarden, Honey Ball 306, Powdery Mildew Resistant 6, 45, and 88, and Seminole. Tolerant *cucumber* varieties: Ashe, Ashley, Fletcher, Palmetto, Stono, Yates Conqueror, and Yates Invader.
9. *Downy Mildews* — General in warm, moist areas. Irregular to angular, yellow to brownish areas on the upper side of leaves near the center of the hill. Underside of diseased leaves may show a pale, grayish-purple mold following damp weather. The mold may vary from white to nearly black in color. Spots enlarge rapidly causing the leaves to wither and die. May resemble frost injury as entire vines are killed. Fruit are often nubbins with poor flavor. See Figure 20C under General Diseases. *Control*: Apply maneb, zineb, or fixed copper at weekly intervals in wet weather, starting when vines "begin to run." Resistant *cucumbers*: Ashe, Ashley, Barclay, Burpee Hybrid, Challenger, Dark Green Slicer, Fletcher, P-51 DMR, Palmetto, Palomar, Santee, Sensation Hybrid, Supermarket Hybrid, Stono, Surecrop Hybrid, and Total Marketeer. Challenger Hybrid has tolerance. Resistant *muskemelons*: Early Market Hybrid, Edisto, Georgia 47, Golden Model, Granite State, Homegarden, Rio Gold, Rio Sweet, Seminole, Smith's Perfect, Supermarket Hybrid, and Weslaco F and H. *Watermelon* varieties also differ in resistance. Control cucumber beetles with malathion, methoxychlor, or dieldrin. See under Bacterial Wilt (above).
10. *Curly-top* — Western states. Vines stunted. Young tip leaves bend upward, are often a darker green than normal and dwarfed while older leaves turn yellow. Leaves puckered and cupped downward. Fruit dwarfed with poor flavor. Yield is reduced. *Control*: Keep down weeds. Destroy infected plants. Control leafhoppers which transmit the virus. Use dieldrin or malathion as given under Bacterial Wilt (above). Resistant *pumpkins*: Big Tom, Calhoun, Chirimen, Cushaw, Kentucky

Field, Sweet Cheese, and Tennessee Sweet Potato. Resistant *squashes*: Long White Bush, and Marblehead (Umatillo and Yakima strains). Resistant *vegetable-marrows*: Boston Creek, Bush Green, Green of Milan, Long Bush Green, Long White Bush, and Zuchetta Nostrana Nana.

11. *Ringspot* — May closely resemble mosaic. Irregular, black, dead areas on watermelons. Leaves may show small brown dots surrounded by light yellow borders. Concentric rings often formed on fruit. Fruit rots may follow. See (17) Spotted Wilt under General Diseases.
12. *Aster Yellows* — Plants stunted and yellowed. Numerous secondary shoots and green, aborted flowers may develop on squash and vegetable-marrow. *Control*: Keep down weeds. By using dieldrin before bloom and malathion after, control leafhoppers which transmit the virus. See under Bacterial Wilt (above). Destroy infected plants when disease is first seen.
13. *White Wilt, Cottony Rot, Southern Blight, Stem Rot, Watery Soft Rot* — Stem rots and dries up at the soil line. A cottony mold grows on the rotted area. Leaves turn yellow and wilt. Infected fruits are soft and watery. May be covered with a cottony mold. *Control*: See under Bean.
14. *Fruit Spots and Rots, Storage Rots* — Cosmopolitan. See under Carrot. Rot often starts where fruit rest on damp soil. Rotted area may be covered with white, black, green, blue, or pink mold growth. *Control*: Plant in well-drained soil. *Cucumber* and *watermelon* varieties differ in resistance. Spray in the field as for Anthracnose (above). Store mature, dry, sound, blemish-free squash and pumpkin fruit at 50° to 60° F. with low relative humidity (80 per cent) after curing at 75° to 85° F. Check with your extension horticulturist. Handle fruit with care. Do not pile fruit over three deep in storage. Where practical in the garden, rest fruit on a dry surface (e.g., a dry mulch). Four-year rotation.
15. *Gummy Stem Blight, Stem End Rot, Leaf Spot* (primarily cucumber, muskmelon, pumpkin, squash, and watermelon) — Widespread. Small to large, water-soaked, gray fruit spots which turn black and gummy. Leaf spots are gray to brown. Leaves may turn yellow and wither. Stem spots oily green in color and gummy. Vines may wilt and die back. *Control*: Same as for Anthracnose (above). Varieties differ in resistance.
16. *Seed Rots, Damping-off* — General. Seeds rot. Stand is poor. Seedlings wilt and collapse. *Control*: Treat seed as for Anthracnose (above). Apply a seedbed spray of captan or ziram (1½ tablespoons per gallon. Use 1 gallon per 125 square feet.) every 5 to 7 days when soil temperature is below 75° F.
17. *Root Rots* — See under Bean, and (34) Root Rot under General Diseases. May be associated with nematodes (e.g., burrowing, dagger, nacobus, pin, ring, reniform, root-knot, root-lesion, spiral, stem, sting, stubby-root, stunt or stylet). *Control*: Same as for Anthracnose (above). Plant in disease-free soil.
18. *Root-knot* — General in southern states. Plants unthrifty and stunted. May wilt on hot days. Swellings or small galls on the roots. Yield is reduced. See Figure 50B under General Diseases. *Control*: Rotate. If necessary, fumigate the soil in the fall after harvest using D-D or Telone. Follow the manufacturer's directions. Many varieties of *cucumber* are highly resistant. Resistant *squashes*: Black Zucchini, Butternut, Caserta, and Early Prolific Straight Neck. The resistance or susceptibility of varieties often depends on what Root-knot species or subspecies are present. Most cantaloups are very susceptible.
19. *Verticillium Wilt* — Plants suddenly wilt, wither, and shrivel up. Brown to black streaks inside the stem. See (15B) Verticillium Wilt under General Diseases. Melon varieties differ in susceptibility.

20. *Blossom Blight* — Blossoms are blighted. May be covered with a dense mold. Young fruit rot and drop off. Rot usually starts at the blossom end. *Control:* Spraying as for Anthracnose and Downy Mildew (both above) is probably beneficial. Plant in well-drained soil. Rotate. Remove and destroy rotting flowers and fruits when first noticed.
21. *Bacterial Spot* (primarily cucumber, gourds, pumpkin, and squash) — Small, round to angular leaf spots between the veins with bright yellow borders. Spots may run together blighting the whole leaf. Spots do not drop out. *Control:* Same as for Angular Leaf Spot (above).
22. *Sooty Mold* — Black mold on foliage and fruit following attack by insects. *Control:* Spray to control insects. See under Bacterial Wilt (above).
23. *Crown Gall* — See (30) Crown Gall under General Diseases.
24. *Web Blight* — Southeastern states. See under Bean.
25. *Stem Streak, Dieback* — Small pink to tan spots on the stems and petioles which soon run together forming long streaks. Affected parts are girdled causing killing and collapsing of the leaves and the portion of the vine beyond. Stems later appear brown. *Control:* Keep plants growing vigorously by applying adequate amounts of a balanced fertilizer based on a soil test. Otherwise same as for Anthracnose (above). No resistant varieties are available.
26. *Boron Deficiency* (primarily squash) — Leaves stunted, yellowed, cupped downward, and brittle. Petioles are curled and thickened. *Control:* Have the soil tested and apply borax as recommended.
27. *2,4-D Injury* — See under Grape. Melons are very susceptible.
28. *Blossom-end Rot* (primarily squash and watermelon) — See under Tomato.
29. *Chlorosis* — Deficiency of iron, manganese or zinc. See page 17.

CUCUMBER - TREE — See Magnolia

CULVERSROOT — See Speedwell

CUNILA — See Salvia

CUPHEA — See Cigarflower

CUP - PLANT — See Chrysanthemum

CUPRESSUS — See Juniper

CURRENT [ALPINE or MOUNTAIN, CLOVE (BUFFALO or MISSOURI), COMMON or GARDEN RED, EUROPEAN BLACK, FLOWERING, GOLDEN, NORTHERN RED, RED-FLOWERED or WINTER, SIBERIAN, WAX], WINTERBERRY, GOOSEBERRY [EUROPEAN, FUCHSIA-FLOWERED, HAIRYSYSTEM] (Ribes)

1. *Leaf Spots, Anthracnose, Spot Anthracnose or Scab* — General. Small, dark spots on the older leaves which may develop gray centers. Spots may run together forming large brown blotches. The lower leaves are affected first. Leaves often turn yellow and drop early. Fruit may be spotted and reduced in size and number. Dark, sunken spots may also occur on the young canes and leaf stems. See Figure 104. *Control:* Space plants. Prune to open up centers of plants. Where practical, collect and burn fallen leaves. Apply fixed copper, zineb, maneb, phaltan, or ferbam following the spray schedule in the Appendix (Table 10). Currant and gooseberry varieties differ in resistance to Anthracnose. Welcome gooseberry is resistant.



Fig. 104. Currant leaf spot and anthracnose.



Fig. 105. Bacterial soft rot of cyclamen.

2. *Powdery Mildews* — General. Most common and serious on gooseberry. Leaves, young shoots and berries are covered with powdery, bluish-white, or light grayish mold patches which later turn a rusty-brown color. Leaves and shoot tips may be stunted and distorted. Leaves attacked by mildew drop early. Berries may be dwarfed and cracked. *Control:* Apply Karathane plus spreader-sticker as the buds start to swell, just before, and just after bloom. Avoid shade and crowding of plants. Prune to "open up" plants. Currant and gooseberry varieties differ in resistance.
3. *Fruit Rots* — General. Fruit rots near picking time. Mold growth may form over rot spots. May be serious in cool, humid weather. *Control:* Same as for Leaf Spots (above). Space plants — keep pruned. If preharvest period is wet, apply captan at 5-day intervals.
4. *Rusts* (primarily Blister and Cluster cup) — Widespread. Small, yellowish to brown, dusty pustules on undersurface of leaves. Bright orange to reddish-yellow or reddish-brown pustules appear on upper surface. Leaves may be curled, thickened, and drop early. Most common on the older leaves. *Control:* Do not plant susceptible currants and gooseberries (*Ribes*) within 1,000 feet of 5-needle pines. These plants are alternate hosts of White Pine Blister Rust; see under Pine. Quarantine regulations prevent the planting of *susceptible* currants and gooseberries in areas where white pine is an important lumber tree. Check with your state department of agriculture before planting currants and gooseberries. Destroy nearby sedges (*Carex* spp.), alternate hosts of Cluster Cup Rust. Destroy rust-susceptible wild *Ribes*. Apply sprays as for Leaf Spots (above). Several weekly applications of ferbam are effective between bud burst and flowering. Be sure to cover both leaf surfaces.
5. *Dieback, Twig Cankers, Black Pustule, Cane-knot Canker, Cane Blights* — Widespread. Tip leaves on young canes suddenly wilt and die. Canes are blighted, dry up, and die back. Most conspicuous just before the fruit ripens. A gray mold, or

small, coral-pink to black pimples may be evident on blighted parts. May follow winter injury. *Control:* Cut out and burn blighted canes before leaves appear. Take cuttings from disease-free plants. Plant in well-drained soil. Avoid heavy applications of fertilizer high in nitrogen. Spray as for Leaf Spots (above).

6. *Collar Rot* — Widespread. Perennial hooflike or shelflike structures, mostly at or near the ground line on older bushes. See (23) Wood Rot under General Diseases. Plants die slowly over several years.
7. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases.
8. *Mosaic* (primarily red currant) — Round, light green to yellowish spots on the leaves. Spots enlarge and run together forming irregular bands along the leaf veins. Leaves may become yellowish with scorched margins. Plants gradually decline in vigor, become stunted, produce less and less fruit. *Control:* Dig up and destroy infected plants when first seen. Control insects with malathion sprays. Plant virus-free stock from a reputable nursery. Destroy nearby wild currants and gooseberries.
9. *Gooseberry Sunscald* — Fruit is soft, pale, and drops early. Often it is covered by various types of mold growth. *Control:* Spray as for Leaf Spots (above). Keep plants growing vigorously (fertilize, and water during dry periods).
10. *Downy Mildew* (gooseberry) — See (6) Downy Mildew under General Diseases.
11. *Verticillium Wilt* — Uncommon. See under Barberry, and (15B) Verticillium Wilt under General Diseases.
12. *Chlorosis* — See under Maple.
13. *Thread Blight* — Southeastern states. See under Walnut. *Control:* Spray as for Leaf Spots (above).
14. *Bud Nematode* — California. See (20) Leaf Nematode under General Diseases. *Control:* Dip infested cuttings in hot water (110° F.) for 30 minutes.

CURUBA, CUSHAW — See Cucumber

CUSHION - PINK — See Carnation

CYCLAMEN

1. *Gray-mold Blight, Botrytis Bud and Leaf Rot, Petal Spot* — Cosmopolitan and serious. Buds may be rotted. Leaves, stalks, and flower petals are spotted. A dense gray mold may cover affected areas in damp weather. Rot may spread gradually into the corm, killing the plant. *Control:* Avoid overcrowding and high rates of nitrogen fertilizer. Increase air circulation. Pick off and destroy affected plant parts. Spray plants and drench soil using captan, maneb, or zineb.
2. *Stunt* — Plants and leaves stunted but not killed. Leaves may turn yellow. Flowers characteristically open *below* the leaves. Reddish-brown dead areas appear when corms are cut through. *Control:* Destroy infected plants as they will not recover. Plant disease-free corms or start seed from healthy plants in clean or sterilized soil. See "Soil Treatment Methods and Materials" in the Appendix.
3. *Bacterial Soft Rot, Tuber Rot* — Leaf and flower stems wilt and droop. Soft, slimy, foul-smelling rot of the petioles and corm (or tuber). See Figure 105. *Control:* Avoid overshading, overstimulating with fertilizer, overwatering, and wounding of underground parts. Plant in sterilized soil. Destroy affected parts. Keep water off the foliage.
4. *Root-knot* — Cosmopolitan. Cyclamen is highly susceptible. See (37) Root-knot under General Diseases.

5. *Root Rot* — Plants sickly. Easily pulled up. Roots and corms are black or white and rotted. May be associated with nematodes (e.g., root-knot, root-lesion). See (34) Root Rot under General Diseases. *Control:* Same as for Bacterial Soft Rot (above). Some control, if early enough, by immersing root clump in a thiram or captan solution.
6. *Leaf Spots, Leaf and Bud Blight, White Mold* — Various types of dead spots in leaves. Leaves may wither and fall early. Buds may be blighted. *Control:* Pick off and destroy infected leaves as they appear. Increase air circulation. Keep water off the foliage. Spray or dip potted plants at 10- to 14-day intervals using captan or zineb. Plant disease-free seed in new or sterilized soil.
7. *Seedling Blight, Damping-off* — Seedlings wilt and collapse from a rot at the soil line. Usually starts in a few plants and spreads outward. *Control:* Plant in sterilized soil. Avoid overwatering and poorly drained soil. Keep the humidity down. If disease starts, sprinkle affected areas with captan or zineb solution (1 tablespoon per gallon). Repeat 5 to 7 days later.
8. *Leaf Nematode* — See (20) Leaf Nematode under General Diseases.
9. *Fusarium Wilt* — See (15A) Fusarium Wilt under General Diseases. *Control:* Same as for Stunt (above).

CYDONIA — See Apple

CYMBIDIUM — See Orchids

CYNARA — See Lettuce

CYNODON — See Lawnglass

CYNOGLOSSUM — See Mertensia

CYPRESS — See Umbrellaplant

CYPHOMANDRA — See Tomato

CYPRESS, CYPRESSUS — See Juniper

CYPRESSVINE — See Morning - glory

CYPRIPEDIUM — See Orchids

CYRILLA — See Buckwheat - tree

CYRTOMIUM, CYSTOPTERIS — See Ferns

CYTISUS — See Broom

DAFFODIL, JONQUIL, NARCISSUS [MINIATURE, POETAZ or CLUSTER FLOWERED, POET'S POLYANTHUS, and TRUMPET] (*Narcissus*); AMARYLLIS [HYBRID, MAGIC LILY], BELLADONNA-LILY (*Amaryllis*); RAINLILY (*Cooperia*); CRINUM; AMAZON - LILY (*Eucharis*); SNOWDROP (*Galanthus*); SPIDERLILY (*Hymenocallis*); SNOWFLAKE (*Leucojum*); HARDY AMARYLLIS (*Lycoris*); TUBEROSE (*Polianthes*); GUERNSEY-LILY (*Nerine*); WINTER- or FALL-DAFFODIL (*Sternbergia*); SCARBOROUGH-LILY (*Vallota*); ATAMASCO-LILY, ZEPHYRLILY (*Zephyranthes*)

1. *Bulb Rots, Root Rots* — General. Plants fail to emerge, or only sickly, stunted shoots come up with weak yellowish or blighted leaves. Bulbs rot usually starting at base. Rot spreads through bulbs to neck. Roots are often rotted. Blue, green, black, gray, or white mold growth often evident on bulb or between the bulb

scales. Usually associated with bulb mites and nematodes (e.g., lance, root-lesion or meadow, spiral). See Figure 49A under General Diseases. *Control:* Plant only high quality, well cured, disease-free bulbs free of cuts, bruises, or other injuries. Discard infected bulbs. Four-year rotation. Space plants. Avoid wounding bulbs and overfertilization, especially with nitrogen. Remove winter foliage mulch in early spring. Carefully remove and burn infected plants including all underground parts together with several inches of surrounding soil. Treat *narcissus* and *snow-drop* bulbs by soaking in a solution containing Ceresan 2 per cent, Emmi, Puratized, Mersolite 8, Dowicide B, or captan following the manufacturer's directions. Or soak bulbs in hot water-formalin solution as for Stem and Bulb Nematode (below). Dry bulbs rapidly after treatment and plant immediately in well-drained soil which is clean or sterilized (pages 437-44). *Narcissus* varieties differ in resistance. Certain rots (Sclerotium and Black Rot) of *narcissus* are controlled by Terraclor (PCNB) dust or spray applied in the furrow at planting time, following the manufacturer's directions. Soak *amaryllis* bulbs before planting for 2 hours in a 1:1,000 solution of mercuric chloride. Plant 1 to 2 days after treatment.

2. *Mosaics, Yellow Stripe, Flower Streak, Gray Disease* — General. Light green, grayish-green, dark green, or bright yellow streaks or an indefinite mottling of the leaves. Flowers often stunted, distorted, and mottled or yellow-streaked. Flower production decreases. Plants more stunted each year. Leaves may be spirally twisted and roughened. See Figure 32D under General Diseases. *Control:* Destroy infected plants when first found, in bloom, and again late in the season. Keep down weeds. Control aphids using malathion or lindane. Avoid growing near onions. Plant only the largest virus-free bulbs available.
3. *Narcissus White Streak, Paper Tip* — General. White streaks develop in leaves after bloom. Tips then dry up and become papery. Finally wilt and collapse. Bulbs are small. Plants mature (decline) very rapidly. *Control:* Same as for Mosaics and Yellow Stripe (above) except destroy diseased plants after blooming. Replant using only the largest bulbs.
4. *Fire, Botrytis Blight, Gray-mold or Leaf Blight, Flower Spot* — Widespread. Often follows chilling. Watery, light brown spots on the flowers. Later, bright yellow, elongated spots with chocolate-brown or reddish-brown centers develop on the leaves. Diseased areas rot rapidly in warm, damp weather. *Narcissus* varieties differ in resistance. *Control:* Same as for Bulb Rots (above). Keep down weeds. Collect and burn tops in the fall. If practical, carefully pick off and burn affected parts as they occur. Apply zineb, maneb, ferbam, captan, dichlone, or fixed copper plus spreader-sticker several times, at about weekly intervals, starting when the leaves are 4 to 8 inches tall. Spray just before wet periods when infections occur.
5. *Leaf Scorch, Red Spot or Blotch, Red Fire Disease* — General. Small, red to reddish-brown or purplish spots or streaks, often with a yellow border, develop on the leaves and flower stalks. Spots may enlarge and run together causing large blotches. Leaves and flower stalks may wither and die prematurely. Flowers may be spotted dark red or brown. See Figure 106A. *Control:* Same as for Fire and Bulb Rots (both above). Indoors, keep water off the foliage. Avoid overwatering, high humidity, high temperatures, and wounding plants. Increase light.
6. *Bud and Leaf Nematode, Stem and Bulb Nematode, Browning or "Ring" Disease (narcissus, lycoris)* — In all commercial bulb-growing areas. Leaves stunted, thickened, and twisted with small, yellowish blisters. Bulbs when cut across show yellow to dark brown rings of infested scales. Badly infested bulbs fail to sprout. See Figure 107, and (38) Bulb Nematode under General Diseases. *Control:* Dig up and burn infested bulbs and adjacent ones which appear healthy, plus 6 inches of surrounding soil. Three-year rotation with nonbulb plants. Keep down weeds.

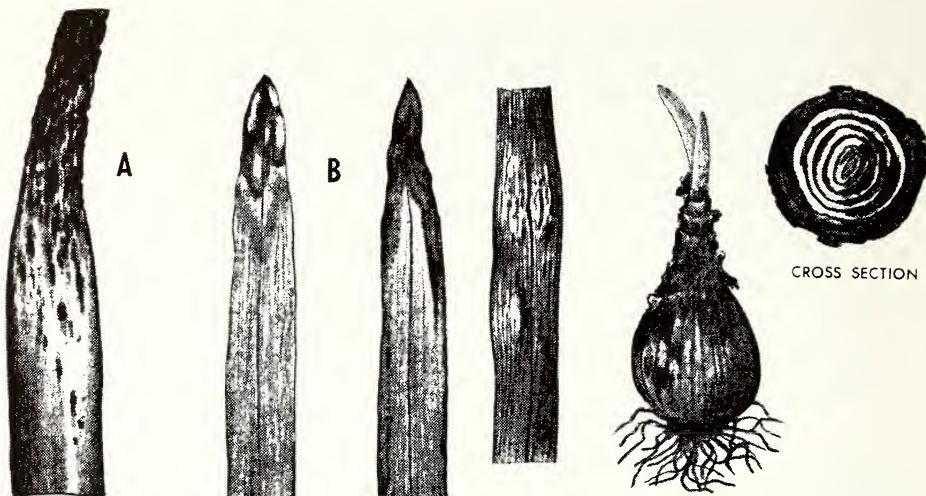


Fig. 106. A. Leaf scorch of narcissus, B. White mold of narcissus.

Fig. 107. Stem and bulb nematode damage to narcissus.

Plant only large, disease-free bulbs in light, well-drained soil fumigated with D-D or EDB, where practical. Commercial growers treat properly cured, *dormant* *narcissus* bulbs by presoaking in water at room temperature (75° F.) for 2 hours followed by soaking 3 to 4 hours in a solution of hot water at exactly 110° to 111° F. and formalin in a proportion of 1:200 or 1 pint of formalin in 25 gallons of water. This treatment also controls mites, bulb flies, and fungi.

7. *Narcissus "Smoulder," Neck Rot* (*narcissus*, *snowdrop*) — Plants stunted or missing. Shoots may be brown and blighted with crumpled leaf tips. Flower stems may rot and flowers develop brown spots. Yellowish-brown rot of bulb in storage. Small,

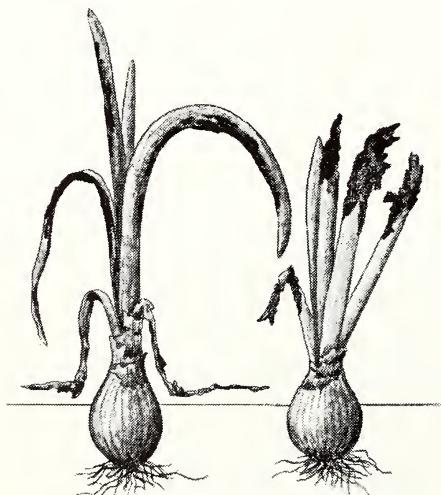


Fig. 108. *Narcissus "smoulder."*

- flattened, black bodies (sclerotia) develop on the "nose" of the bulb, between the husks, or at both places. See Figure 108. Serious in cold, wet weather. *Control:* Same as for Bulb Rots (above). Destroy badly infected plants or plant parts. Spray as for Fire (above). Keep down weeds.
8. *Narcissus White Mold, Ramularia Blight* — Pacific Northwest. Sunken, yellow to gray spots or streaks appear on the leaves, then enlarge and turn dark green to yellowish-brown with a yellow margin. Leaves and flower stalks rot quickly. Affected areas are covered with a white, powdery mold in wet weather. May resemble frost injury. See Figure 106B. Varieties differ in susceptibility. *Control:* Same as for Fire (above). Spray with fixed copper or zineb plus spreader-sticker.
9. *Amaryllis Spotted Wilt* — Numerous pale yellow or white spots on the leaves. Reddish-brown spots or red lines may develop, especially along the leaf edges. Leaves usually later turn yellow and die. *Control:* Same as for Yellow Stripe (above). Control thrips which transmit the virus. Use DDT and malathion.
10. *Root-lesion (Meadow) and other Root-feeding Nematodes* (e.g., lance, pin, sheath, spiral) — Plants and bulbs often stunted. Foliage turns yellow and withers prematurely in certain areas. Eventually the whole plant may wilt and die. Roots are few, short, and stubby. Often show dark spots or rot. *Control:* Plant in clean or sterilized soil (pages 437-44). Use D-D, chloropicrin, or EDB following the manufacturer's directions.
11. *Root-knot* — See (37) Root-knot under General Diseases. *Control:* Same as for Root-lesion Nematodes (above). Soak Tuberose tubers, offsets, or "seed" in hot water (120° F.) for 1 hour.
12. *Yellow Dwarf* — Plants stunted and yellowish. See under Onion.
13. *Leaf Spot* — Small, water-soaked spots appear on the leaves after blooming is over. Spots enlarge, turn grayish-brown, and run together. Leaves often wither and die early. *Control:* Destroy spotted leaves. Spray as for Fire (above).
14. *Rust* (atamasco-lily, rainlily, zephyranthes) — Southern states. Yellow, orange, reddish-brown, or black powdery pustules on leaves. *Control:* Spray as for Fire (above). Destroy rusted leaves.

DAHLIA — See Chrysanthemum

DAHOON — See Holly

DAISY — See Chrysanthemum

DAMESROCKET — See Cabbage

DANGLEBERRY — See Blueberry

DAPHNE [CAUCASIAN, LILAC, WINTER], MEZEREUM, GARLAND FLOWER, SPURGE LAUREL (*Daphne*)

1. *Leaf Spots, Anthracnose* — Widespread. Thick, brown, purplish, reddish, or irregular greenish spots on the leaves. Leaves may later turn yellow, wither, and fall prematurely. *Control:* Pick off and burn infected leaves. Spray several times, 10 to 14 days apart, using fixed copper, zineb, maneb, or captan.
2. *Twig Blight, Canker, Dieback* — Twigs blighted. Twigs and branches die back. May be covered with small, coral-red "cushions." *Control:* Cut off and burn infected parts. Spraying as for Leaf Spots may be beneficial.
3. *Crown Rots, Stem Rot, Wilts* — See under Delphinium.
4. *Mosaic* — Leaves mottled yellowish-green. Plants may be stunted. *Control:* Destroy

infected plants. Control insects which spread the viruses, using DDT and malathion. See (16) Mosaic under General Diseases.

5. *Winter Injury* — Foliage scorched following an ice crust.

6. *Wilts (Verticillium and Fusarium)* — Rare. See (15A) and (15B) Fusarium and Verticillium Wilts under General Diseases.

DASHEEN — See Calla

DATURA — See Tomato

DAYFLOWER — See Tradescantia

DAYLILY — See Hemerocallis

DECUMARIA — See Hydrangea

DEERGRASS, MEADOWBEAUTY (*Rhexia*)

1. *Leaf Spots* — Spots of various colors, sizes, and shapes on leaves. *Control:* Pick off and burn spotted leaves. If serious enough, spray several times, 10 days apart, during rainy periods. Use zineb, maneb, or captan.

DELPHINIUM, LARKSPUR [BOUQUET, CANDLE or GARLAND, CHINESE, RED, ROCKET or ANNUAL, and SCARLET] (*Delphinium*); MONKSHOOD, ACONITE (*Aconitum*); COLUMBINE (*Aquilegia*); GOLDTHREAD (*Coptis*); CHRISTMAS-ROSE (*Helleborus*); PEONY, TREE PEONY (*Paeonia*); BUTTERCUP, CROWFOOT (*Ranunculus*); MEADOWRUE (*Thalictrum*)

1. *Stem Cankers, Southern Blight, Wilt, Stem, Crown, and Root Rots* — General and serious. Stems stunted, suddenly or gradually wilt, may turn yellow, darken, and die. Often collapse. Infected plants are easily pulled up. Stems cankered or rotted at or near the soil line. May have a foul odor. Roots are often decayed. White fungus threads and tan to dark seedlike bodies (sclerotia) may form at the crowns. *Control:* Dig up and divide older clumps. Dig up and burn severely diseased plants, including 3 to 5 inches of surrounding soil. Plant disease-free stock or seed from disease-free plants. Treat suspicious *delphinium* seed by soaking in hot water (130° F.) for 10 minutes. Cool, dry, and plant. Plant in clean or sterilized soil (pages 437-44) which is well-drained and in a sunny spot. Rotate. Avoid overwatering, wounding stems, and a wet mulch around crowns. In the fall after cutting and burning the tops, and again in early spring, drench crowns and surrounding soil several times, a week apart, using Semesan or a 1:2,000 solution of mercuric chloride. See pages 85 or 427 for precautions. Certain rots are controlled by working Terraclor (PCNB) dust into the top 4 to 6 inches of soil, a week or more before planting. Or apply a soil drench of Terraclor 75 per cent (1 pint per square foot). Follow the manufacturer's directions. Spraying in the spring as for Gray-mold Blights (below) is often beneficial.

2. *Gray-mold Blights, Botrytis Blight, Flower Blight, Bud Blast* — General. Young shoots may wilt and collapse from a soft brown to black rot near the soil line. Buds turn brown or black and fail to open, or flowers are brown-spotted, watery, and matted. Large, irregular, brown blotches may occur on the leaves. A coarse gray mold grows on affected areas in damp weather. Peony buds that turn brown and dry from pea to marble size may be due to the feeding of thrips, frost injury (especially if the potash supply in the soil is low), lack of water and soil

nutrients, and other factors. See Figure 19B under General Diseases. *Control:* Cut and burn tops at ground level in the fall. Spray with captan, zineb, ferbam, or maneb (1½ tablespoons per gallon) plus spreader-sticker as the shoots emerge. Repeat 10, 20, and 30 days later. Apply the last spray as flowers start to open. Additional sprays at 2-week intervals after bloom may be needed if the period is rainy or humid.

3. *Mosaic, Ringspot* — General. Symptoms variable. Plants may be stunted with mottled, pale green, and yellow leaves with lemon-yellow to orange-amber leaf spots, blotches, line patterns, bands, arcs, or striking, zoned rings with "green islands." Flowering may be prevented. See Figure 109. *Control:* Do not propagate from infected plants. Destroy diseased plants when first seen. Keep down weeds. Control insects, especially aphids, using malathion sprays.
4. *Delphinium and Aconitum Black Blotch, Bacterial Leaf Spot* — Widespread in cool, wet weather. Small, water-soaked spots which later are irregular, shiny, and tarlike with yellow borders. Mostly on leaves, but also on buds, stems, and blossoms. Lower leaves are infected first. See Figure 16C under General Diseases. *Control:* Plant disease-free stock in clean soil. Destroy infected leaves as they appear. Cut and burn tops in the fall. If possible, keep water from splashing on the foliage. Three to 4-year rotation. Drench crowns and soil when plants are 6 to 10 inches tall using zineb, maneb, fixed copper, or Semesan. Thereafter spray weekly with fixed copper and spray lime (3 tablespoons of each per gallon of water), if serious enough.
5. *Powdery Mildews* — General. Powdery, white mold growth on leaves. Varieties differ greatly in resistance. *Control:* Spray two or three times, 10 days apart, using Karathane, Acti-dione, or sulfur. *Delphinium* varieties differ in resistance.
6. *Yellows, Stunt, Witches'-broom, "Greens"* — General. See under Chrysanthemum.
7. *Seed Rot, Damping-off* — Cosmopolitan. Seed rot. Stand is poor. Seedlings wilt and collapse. *Control:* Sow seeds in sifted sphagnum moss or other suitable starting medium.
8. *Wilts (Fusarium and Verticillium)* — Plants gradually wilt, wither, and die about blooming time, starting at the base. Insides of stems and crowns show green to brown or black streaks. Fusarium also causes light brown, water-soaked areas (cankers) on the stems. *Control:* Dig up and destroy infected plants. Plant disease-free stock in clean or sterilized soil that has not grown wilted plants. See "Soil Treatment Methods and Materials" in the Appendix.
9. *Crown Gall* — See under Begonia, and (30) Crown Gall under General Diseases.
10. *Root-knot and Other Root-feeding Nematodes* (e.g., dagger, lance, root-lesion or meadow, spiral, stem) — Small galls usually ¼ to ½ inch in diameter form on the finer roots (Root-knot). Roots may die back or be stunted and bushy. Plants lack vigor, may be stunted, spindly, pale in color, and do not bloom normally. *Control:* Plant nematode-free roots or planting stock in clean or sterilized soil (pages 437–44). Drench around established plants using Nemagon, Fumazone, or VC-13 Nemacide following the manufacturer's directions. Disinfest dormant peony roots by soaking in hot water (120° F.) for 30 minutes.
11. *Leaf Spots, Leaf Blight or Blotch, Anthracnose, Black Spot* — Small to large leaf spots or blotches of various colors. May run together forming irregular dead areas. Leaves may wither and die prematurely. Similar spots may also occur on the stems, petioles, and flower petals. See Figure 110. *Control:* Cut and burn tops in the fall.



Fig. 110. Black spot of Christmas-rose.

Fig. 109. Peony ringspot.

Spray foliage as for Gray-mold Blights (above). Propagate only from disease-free plants.

12. *Rusts* (aconitum, buttercup, columbine, delphinium, meadowrue) — Widespread. Small yellow spots on the leaves. Alternate hosts include various grasses, barley, *Prunus* spp., and *Polygonum viviparum*. *Control:* Spray as for Gray-mold Blights (above).
13. *LeMoine Disease of Peony* — Common. Plants dwarfed with spindly shoots. Produce no flowers. Roots irregularly swollen, short, and stubby. *Control:* Dig up and burn infected plants. Plant disease-free stock in a new location.
14. *Peony Crown Elongation Disease, Witches'-broom* — Small leaves on dwarfed, slender shoots. Crowns elongated with weak buds at tips. Plants do not flower. *Control:* Same as for LeMoine Disease (above).
15. *Leaf and Stem Smuts, White Smut* — Blister-like swellings on leaves and leaf stalks which are later filled with a black powder. *Control:* Same as for Stem Rots (above). Pick off and burn diseased parts before blisters open.
16. *Curly-top* — Western states. Plants stunted with younger leaves curled and bunched on the main stem and side branches. See (19) Curly-top under General Diseases.
17. *Spotted Wilt, Ringspot* (buttercup, columbine, dahlia, delphinium, peony) — See under Bellflower, and (17) Spotted Wilt under General Diseases.
18. *Leaf and Stem Nematode* — See (20) Leaf Nematode under General Diseases. Branches may be aborted and foliage distorted.
19. *Flower Spot or Blight* — Flower petals are spotted. Spots may enlarge, blighting the complete flower. See (31) Flower Blight under General Diseases.
20. *Peony Oedema, Measles* — Many small, blister-like, brown or purple spots on the leaves and stems. Believed associated with high soil and air moisture. *Control:* Unnecessary.
21. *Peony Bud Blast* — General. Buds reach the size of small peas but fail to develop further. Associated with low potassium in the soil, late spring frost or dry periods, root-knot infection, too deep planting in infertile soil, or excessive shade. *Control:* Avoid as many of these factors as possible.
22. *Downy Mildew* (buttercup, meadowrue) — Occasional. See (6) Downy Mildew under General Diseases. *Control:* Spray as for Gray-mold Blights (above).
23. *Chlorosis* — See under Rose. May also be caused by low temperatures and wet soil.

24. *Thread Blight* — Southeastern states. See under Fig.
25. *Delphinium "Blacks"* — Caused by minute cyclamen mites. Plants stunted, curled, and seriously deformed. Buds turn black. Are deformed and distorted. Dark brown to black streaks and blotches occur on the stems and petioles. *Control:* Check with your extension entomologist regarding a suitable spray program.
26. *Leaf Curl* (peony) — Plants dwarfed with curled leaves. Flower stalks cracked. *Control:* Dig up and destroy infected plants.

DENDROBIUM — See Orchids

DENDROMECON — See Poppy

DENNSTAEDTIA — See Ferns

DENTARIA, DESERTPLUME — See Cabbage

DESERT-WILLOW — See Catalpa

DEUTZIA — See Hydrangea

DEVILSCLAW — See Proboscisflower

DEVILWOOD — See Osmanthus

DEWBERRY — See Raspberry

DIANTHUS — See Carnation

DICENTRA — See Bleedingheart

DIDISCUS — See Celery

DIEFFENBACHIA — See Calla

DIGITALIS — See Snapdragon

DILL — See Celery

DIMORPHOTHECA — See Chrysanthemum

DIOSCOREA — See Yam

DIOSPYROS — See Persimmon

DIPSACUS — See Teasel

DIRCA — See Leatherwood

DITTANY — See Salvia

DODECATHEON — See Primrose

DOGSTOOTH-VIOLET — See Erythronium

DOGWOOD [BAILEY, BLOODTWIG, CHINESE, FLOWERING, GRAY, or PANICLED, JAPANESE CORNEL, PACIFIC, PAGODA or ALTERNATE-LEAVED, PINK, RED or TATARIAN, RED-OSIER, RED-TWIGGED, SIBERIAN, VARIEGATED, WHITE, WEEPING WHITE, YELLOW-TWIGGED], CORNEL [DWARF or BUNCHBERRY, ROUGHLEAF, SILKY]; OSIER [RED, WESTERN], CORNELIAN CHERRY, JAPANESE CORNELIAN CHERRY (*Cornus*); TASSELTREE, SILKTASSEL-BUSH (*Garrya*); TUPELO (SOUR GUM, BLACK GUM), WEEPING TUPELO (*Nyssa*)

1. *Dogwood Collar Rot, Trunk or Bleeding Canker* — Widespread in eastern states. Trees lack vigor. Leaves dwarfed and pale green. Later the leaves turn yellow or prematurely red in late summer. Drop early. Twigs and branches are stunted. May die back; frequently on one side of the tree. Sunken canker on the lower trunk,



Fig. 111. Dogwood collar rot.

crown, or roots which enlarges slowly for several years. Girdles the trunk killing the parts beyond. See Figure 111. Cankers ooze sap in the spring. Trees may die. *Control:* Dig up and burn trees showing large cankers (over halfway around). Do not replant in the same soil for several years without drenching first with one part formalin in 50 parts of water or use zineb. Remove smaller cankers promptly. Cut out $1\frac{1}{2}$ inches of surrounding "healthy" bark and discolored wood. See Figure 10. Paint the wound edges with orange shellac. Swab the remainder with household bleach (diluted 1:5 with water), a 1:1,000 solution of mercuric chloride, or bordeaux paste. Finally paint with tree wound dressing. Keep trees growing vigorously. Avoid wounding trunk during transplanting, mowing, etc. Keep the base of the trunk dry and free of wounds. Plant trees in well-drained soil. Control borers by painting or spraying the trunk and branches with DDT or dieldrin. Do not spray the foliage with DDT. Check with your county agent or extension entomologist regarding timing of sprays.

2. *Leaf Spots, Spot Anthracnose* — Widespread. Spots of various sizes, shapes, and colors, often with dark purple to brown borders (Figure 112). Spots on leaves may drop out leaving ragged holes. Common in wet seasons. Certain spots also occur on young stems, flowers, and berries. If severe, leaves may drop early. Flowers may be stunted and malformed. *Control:* Apply same spray materials as for Gray-mold Blight (below) or use maneb, phaltan, or phenyl mercury. Spray just before and after bloom. Then repeat monthly to August. Collect and burn fallen leaves in autumn. Keep trees pruned.
3. *Gray-mold Blight, Flower and Shoot Blight, Bud Blight* — Widespread in wet springs. Irregular brown areas on fading flowers and leaves. May be covered with a grayish mold in damp weather. Buds are blasted. *Control:* Apply captan or zineb just before, during, and after bloom. If possible, spray just before wet periods. Prune to keep trees open.
4. *Powdery Mildews* — General. Leaves covered with white, powdery mold patches in late summer and fall. *Control:* If serious enough, add Karathane or sulfur to Leaf Spot sprays (above).
5. *Twig Blights, Branch and Trunk Cankers, Dieback* — Twigs and branches die back from girdling, discolored cankers. *Control:* Prune and burn infected branches back to healthy wood. Paint wounds promptly as for Collar Rot (above). Keep trees vigorous by watering and fertilizing. Spraying as for Leaf Spots (above) should be beneficial.
6. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases. Often associated with root-feeding nematodes (e.g., dagger, lance, pin, root-knot, spiral, sting, stubby-root).
7. *Wood Rots, Heart Rot* — See under Birch, and (23) Wood Rot under General Diseases.
8. *Sooty Mold, Black Mildew* — Mostly in southeastern states. See under Apple, and (12) Sooty Mold under General Diseases.
9. *Leaf Scorch* — Margins of leaves turn light brown on trees growing in full sun and in poor soil. Scorch develops in July and August following hot, dry, windy weather. *Control:* Have the soil tested. Apply fertilizer as recommended. Prune trees to keep them growing vigorously. Water during summer dry periods.
10. *Sunscauld* — Results in death of young trees during the first few years following transplanting. Often due to sunscald, lack of soil moisture, and careless handling of trees too large for easy transplanting. *Control:* Transplant small trees into partial shade. Wrap or shade the south and southwest sides of the tree trunk. See under Apple, and Figure 12. Water and fertilize properly.
11. *Crown Gall* — See under Apple, and (30) Crown Gall under General Diseases.
12. *Verticillium Wilt* — See under Maple.
13. *Rust* (dwarf cornel, tupelo) — Widespread. Small, reddish-brown to black, powdery pustules on the leaves. *Control:* If serious enough, spray as for Leaf Spots (above), using zineb or maneb.
14. *Mistletoe* — See (39) Mistletoe under General Diseases.
15. *Thread Blight* — Southeastern states. See under Walnut. *Control:* Spray as for Leaf Spots (above).
16. *Felt Fungus* — Southeastern states. Purple-black, feltlike growth associated with scale insects. See under Hackberry.
17. *2,4-D Injury* — See under Grape. Dogwoods are very susceptible.

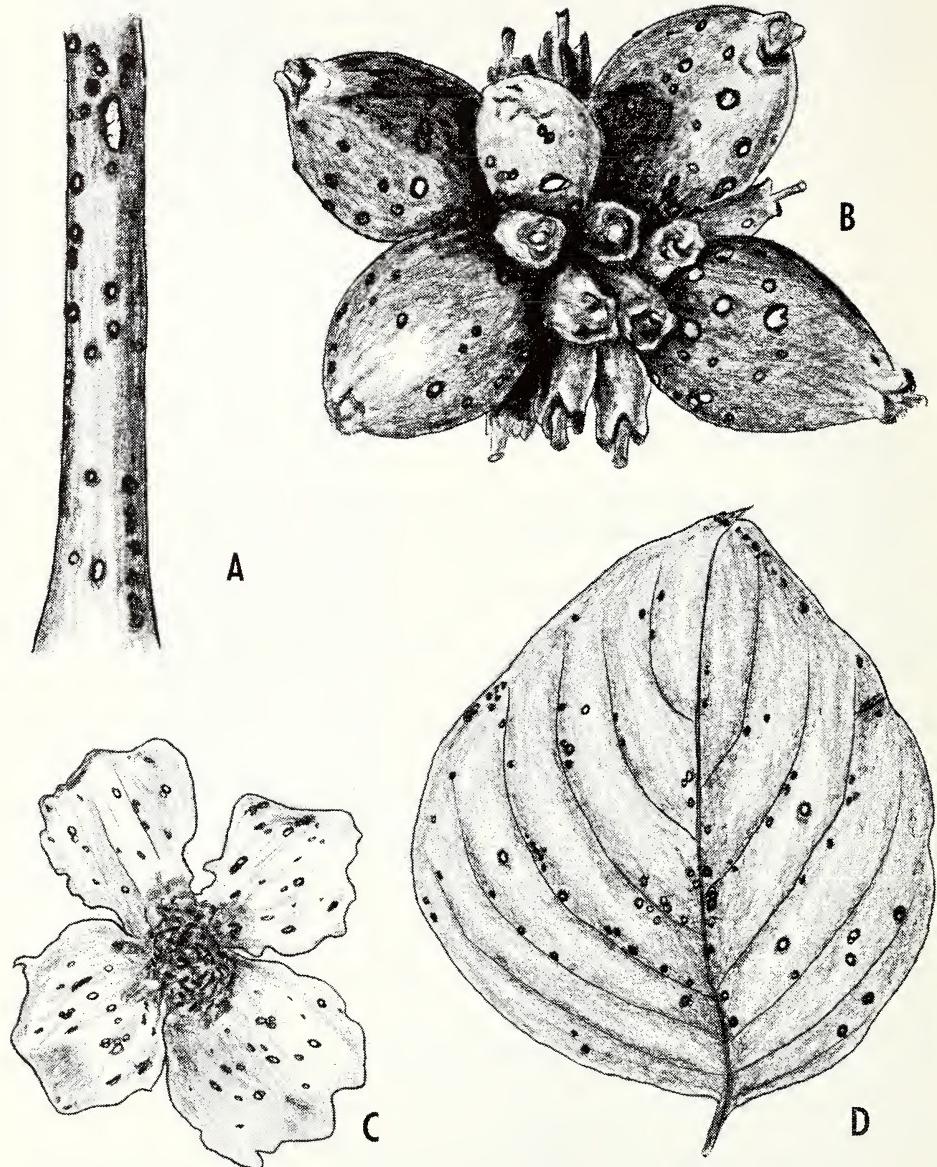


Fig. 112. Spot anthracnose of dogwood. Spots on: A. Stem, B. Berries, C. Flower, D. Leaf.

DOLICHOS — See Pea

DOUGLAS-FIR — See Pine

DORONICUM — See Chrysanthemum

DOXANTHA — See Trumpetvine

DRABA — See Cabbage

DRACAENA, CORDYLINE

1. *Leaf Spots, Tip Blight, Anthracnose* — General. Round to irregular spots of various colors on the leaves. Centers of spots may be sprinkled with black dots. The lower and center leaves may die back from the tips. See Figure 113. If severe, all leaves may wither and die except a few leaves at the top of the plant. *Control*: Keep water off the foliage. Destroy infected leaves when first seen. If necessary, apply zineb, maneb, copper, or captan sprays, at 7- to 10-day intervals during rainy weather.
2. *Chlorosis* — Plants yellowish and sickly. Most prevalent on poorly drained acid or alkaline soils. *Control*: Spray weekly for a month using iron sulfate or an iron chelate, following the manufacturer's directions. Plant in well-drained soil which is nearly neutral (about pH 6.5 to pH 7.2).
3. *Gray-mold Blight* — May cause extensive soft brown rotting in damp periods. Affected areas are covered with a coarse grayish mold. *Control*: Same as for Leaf Spots (above).
4. *Root Rot* — See (34) Root Rot under General Diseases.
5. *Root-knot* — See (37) Root-knot under General Diseases.
6. *Stem Rot* — Leaves turn yellow starting at the base of the stem. Plants wilt. The lower part of the stem is rotted, black, and water-soaked. *Control*: Plant disease-free stock or tip cuttings in clean or sterilized soil (pages 437-44). Watering with zineb, captan, thiram, or ferbam (1 tablespoon per gallon) during rooting may be beneficial.
7. *Root-feeding Nematodes* (lance, sheath) — Plants may appear sickly and gradually decline. May be associated with Root Rot. *Control*: Same as for Root Rot and Root-knot (both above).

DRACOCEPHALUM, DRAGONHEAD — See Salvia

DRAGONROOT — See Calla

DROPWORT — See Rose

DRYOPTERIS — See Ferns

DUCHESNEA — See Rose

DUSTY - MILLER — See Chrysanthemum

DUTCHMANS-BREECHES — See Bleedingheart

DUTCHMANS-PIPE — See Aristolochia

DWARF LACEPLANT — See Silver Lacevine

DYER'S GREENWEED — See Broom

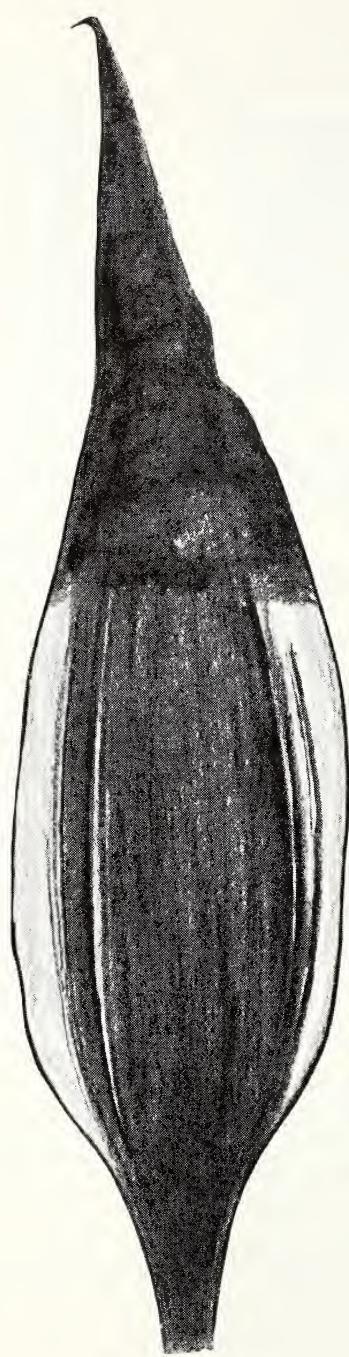


Fig. 113. *Dracaena* tip blight.

DYSCHORISTE — See *Clockvine*

ECHEVERIA — See *Sedum*

ECHINACEA — See *Chrysanthemum*

ECHINOCACTUS — See *Cactus*

ECHINOCYSTIS — See *Cucumber*

ECHINOPS — See *Chrysanthemum*

EGGPLANT — See *Tomato*

ELAEAGNUS — See *Russian-olive*

ELDER — See *Snowberry*

ELECAMPANE — See *Chrysanthemum*

ELEPHANTS-EAR — See *Calla*

ELM [AMERICAN (many horticultural varieties), CEDAR, CHINESE,
CHRISTINE BUISMAN, DUTCH, ENGLISH, HYBRID, JAPANESE, MOLINE,
RED or SLIPPERY, ROCK or CORK, SCOTCH, SIBERIAN or DWARF,
SMOOTH-LEAVED EUROPEAN, WEEPING, WINGED or WAHOO, WYCH]
(*Ulmus*); JAPANESE ZELKOVA (*Zelkova*)

1. *Dutch Elm Disease* — Roughly the eastern half of the United States and spreading westward. Serious. Leaves wilt, often turn yellow to brown, curl, and usually drop

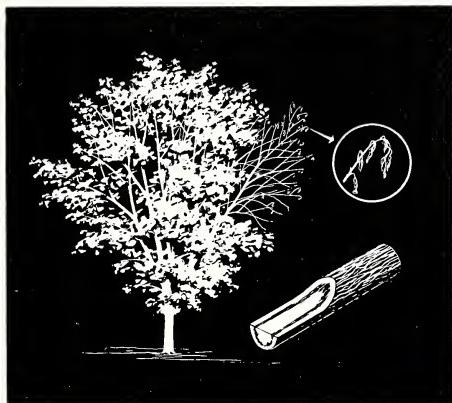


Fig. 114. Dutch elm disease. Note shepherd's crook and cut twig showing dark discoloration in the outer sapwood. The causal fungus makes the water-conducting tissue nonfunctional.

early on one or more branches. Twig tips may curve downward to form "crooks." Branches die back. Entire trees may die in 1 to 2 months; others survive 1 to 3 years or longer. A brown to black discoloration occurs in the white sapwood just under the bark in wilting branches. Positive identification is possible only through laboratory culturing. See Figure 114. *Control:* A community-wide program is needed in threatened areas. Remove and burn all dead and dying elm trees as soon as found. Clean up and burn all dead elm wood (with tight bark) in trees or on ground before trees leaf out in early spring. Debark stumps and fireplace wood. Repair and paint tree wounds promptly. Keep trees growing vigorously by proper watering and fertilizing. A single dormant spray of DDT is recommended

in many areas where the disease is present. Check with your park department, city arborist or forester, local arborist or county agent. The DDT spray kills the bark beetles which transmit the Dutch elm disease fungus. Beetles are spread long distances by road and rail traffic. Resistant elms: Christine Buisman, Chinese, Siberian, Hybrid, and European Field. These trees are not immune to the disease. *Infected trees cannot be saved or cured.*

2. *Phloem Necrosis* — Serious in the eastern and central United States below 40° North latitude. During June and July, leaves roll upward, turn yellow, wither, and fall starting throughout the upper crown. Foliage is thin. Trees showing symptoms usually drop their leaves and die within a month or two. The inner bark, especially that near the base of the trunk, is often butterscotch-colored, sometimes flecked with brown or black. When such bark is warmed in a tightly closed jar, an "oil of wintergreen" odor is often evident. Roots die first. *Control:* Chinese, Christine Buisman, and Hybrid elms are highly resistant or immune. Spray susceptible elms with DDT and malathion to control leafhoppers which transmit the virus. Two applications are usually made, 35 to 40 days apart. Check with your city forester, county agent, or extension entomologist regarding timing of sprays for your area. *Infected trees cannot be saved or cured.*

3. *Other Wilts, Diebacks* (*Verticillium, Dothiorella* = *Cephalosporium* or *Deuterophaoma*) — Widespread. External and internal symptoms often closely resemble Dutch elm disease, but infected trees may live on for a number of years, slowly dying back and declining in health. Leaves may be dwarfed and yellowed. Sucker growth is common on the trunk and larger branches. Laboratory culturing is needed for positive diagnosis. *Control:* Remove and burn severely infected trees. On others, remove infected branches flush with the next larger limb or trunk. Disinfect pruning tools between cuts. Keep trees vigorous by fertilizing liberally, plus watering during dry periods. Spray as for Black Leaf Spot (below).

4. *Black Leaf Spot* — General, especially in wet seasons. Small, irregular, grayish spots on the leaves. Later the spots become shiny and black. Infected leaves often turn yellow or brown and drop early in large numbers. See Figure 115. Trees vary greatly in susceptibility. Twigs may die back. *Control:* Collect and burn fallen leaves. Where practical, spray as the leaves unfold, and repeat 2 and 4 weeks later. Apply fixed copper, dichlone, zineb, phenyl mercury, or ferbam, plus spreader-sticker.

5. *Anthracnose, Leaf Spot, Twig Blight* — General. Irregular, brown spots or dead areas in leaves between the veins and margins. Twigs may die back. *Control:* Same as for Black Leaf Spot (above) except spray as the buds break open, 7 and 14 days later.

6. *Wetwood, Slime Flux* — Widespread and common. Asiatic elms are very susceptible. Fermenting, dark-colored sap flows down from a branch stub, split crotch, or other bark wound, especially in the spring or following wet weather. The sap dries to form a light grayish-tan stain on the trunk and larger branches. See Figure 116. On young trees, the leaves on one or more branches may wilt, curl, turn color, and drop early. Branches on older trees die back gradually and the foliage is a sickly yellow color. Trees gradually decline in health. Often associated with wet soil, mechanical damage to the roots, branches, trunk and crotches, or to frost cracks. *Control:* Fertilize and water to stimulate vigor. Prune out dead and weak branches. Repair bark wounds promptly (page 22). Cover with tree wound dressing. Check with a good tree surgeon. Trees may need cabling, bracing, or drain pipes installed.

7. *Twig Blights, Diebacks, Cankers* — Widespread. Twigs and branches die back from cankers (bark often discolored or shows small, coral-pink to black "pimples" on the surface). May follow winter, drought, or insect injury. Leaves on affected branches are often dwarfed or wilt later in the summer. *Control:* Prune out and burn dead



Fig. 115. Black leaf spot of elm.

Fig. 116. Wetwood or slime flux of elm.



- twigs and branches. Make cuts several inches beyond any visible sign of infection. Paint wounds promptly with a good tree wound dressing. Fertilize and water to maintain tree vigor.
8. *Wood Rots, Heart Rots* — Cosmopolitan. See under Birch, and (28) Wood Rot under General Diseases.
 9. *Root Rot* — Trees gradually decline in vigor. Foliage is thin and sickly. Leaves may turn yellow, wither, and fall early. May be associated with nematodes. *Control:* See under Apple.
 10. *Winter Injury, Sunscald, Frost Crack, Winter Drying* — Twigs and branches may die back from the tips. Dwarfed, sickly leaves may unfold on affected branches and then die. In the spring limbs fail to leaf out. *Freezing Injury:* Inner bark may be water-soaked at first and then very dark. Several or all limbs may die. Long, up-and-down cracks (Frost Cracks) or large, dead, discolored areas (Frost Cankers) may form on the exposed south or southwest side of the trunk and larger limbs. *Control:* Water trees during dry periods, especially in a dry fall. Keep the crown of the tree pruned open. Fertilize in the spring. Wrap young trees with burlap, sisalkraft paper or otherwise shade from winter sun. See Figure 12.
 11. *Mosaic, Mottle-leaf* — General. Infected leaves are abnormally large or small. Leaves stiff, often distorted. Dwarfed leaves are usually mottled light green and yellow.

- Witches'-brooms may form on twigs. Tree gradually lose vigor over a period of years. Foliage appears thinner and branches die back. *Control:* Where practical, replace with virus-free trees. No control is known.
12. *Physiological Leaf Scorch* — Browning or scorching of leaves between the leaf veins, along the margins, or both places following hot, dry, windy weather in July and August. *Control:* Fertilize and prune out trees to increase vigor. Water during summer dry periods.
13. *Bleeding Canker* — Northeastern states. See under Beech and Maple.
14. *Leaf Blister* — Small, grayish-white blisters on thickened, puckered leaves. These leaves may later turn yellow and drop early. *Control:* Same as for Anthracnose (above).
15. *Powdery Mildews* — General. White, powdery mold patches on leaves. Leaves may later shrivel. *Control:* If serious enough, spray twice, 10 days apart, using Karathane or sulfur.
16. *Root-knot* — Elm is highly susceptible. See under Peach, and (37) Root-knot under General Diseases.
17. *Sooty Mold* — Black, sooty mold grows in "honeydew" produced by aphids and scale insects. *Control:* Not necessary. Spray with DDT and malathion to control elm insects.
18. *Seed Rot, Seedling Blight* — See under Pine.
19. *Virus Scorch of American Elm* (southeastern states) — Elm leaves appear scorched at the margins and between the veins. Growth is stunted. Trees decline in vigor and the crown gradually dies back. Later the tree dies. *Control:* Check with your city arborist or park department. Destroy infected trees. Seek out virus-free stock from a reliable nursery.
20. *2,4-D Injury* — Elms are very susceptible. See under Grape.
21. *Mistletoe* — See (39) Mistletoe under General Diseases.
22. *Thread Blight* — Southeastern states. See under Walnut.
23. *Other Root-feeding Nematodes* (dagger, lance, ring, spear, spiral, stylet or stunt, stem) — Often associated with sickly, unthrifty trees. See under Peach.
24. *Chlorosis* — See under Maple. Occurs in alkaline soils.

EMILIA — See Chrysanthemum

EMPRESS-TREE — See Paulownia

ENCELIA — See Chrysanthemum

ENDIVE — See Lettuce

ENGELMANN IVY — See Grape

ENGLISH DAISY — See Chrysanthemum

ENGLISH IVY — See Ivy

EPIDENDRUM — See Orchids

EPIGAEA — See Heath

EPIPHYLLUM — See Cactus

EPISCIA — See African-violet

ERANTHEMUM — See Clockvine

EREMOCHLOA — See Lawnglass

ERICA — See Heath

ERIGERON — See Chrysanthemum

ERIOBOTRYA — See Apple

ERODIUM — See Cranesbill

ERYNGIUM, ERYNGO — See Celery

ERYSIMUM — See Cabbage

ERYTHRINA — See Honeylocust

**ERYTHRONIUM, DOGSTOOTH-VIOLET, YELLOW ADDERSTONGUE,
TROUTLILY, FAWN LILY, ADAM-AND-EVE (*Erythronium*)**

1. *Leaf Spot, Leaf Blight, Black Spot* — Small specks or spots on the leaves. Leaves may later turn yellowish, wither, and collapse. *Control:* Pick off and burn spotted or blighted leaves when first noticed.
2. *Leaf Smuts* — Widespread. Large, blister-like swellings on the leaves which break open to release brownish-black, powdery masses. Leaves may crack open and die. *Control:* Same as for Leaf Spot (above).
3. *Botrytis Blights* — See (5) Botrytis Blight under General Diseases.
4. *Rust* — Western states. See (8) Rust under General Diseases.

ESCAROLE — See Lettuce

ESCHSCHOLTZIA — See Poppy

EUPHARIS — See Daffodil

EUONYMUS — See Bittersweet

EUPATORIUM — See Chrysanthemum

EUPHORBIA — See Poinsettia

EUROPEAN CRANBERRY-BUSH — See Viburnum

EUSTOMA — See Gentian

**EVENING-PRIMROSE [COMMON, WHITE], MISSOURI PRIMROSE,
SUNDROPS, GOLDENEGGS (*Oenothera*); CALIFORNIA FUCHSIA, FIRE-
CHALICE (*Zauschneria*)**

1. *Rusts* — General. Yellow-orange or reddish-brown, powdery pustules, mostly on underleaf surface. See (8) Rust under General Diseases. Alternate hosts include wild grasses and sedges (*Aristida*, *Distichlis*, and *Carex* spp.).
2. *Powdery Mildew* — General. See (7) Powdery Mildew under General Diseases. Usually causes little injury.
3. *Leaf Spots, Leaf Gall, Anthracnose* — Round to irregular, variously colored spots, often with a dark margin. If severe, leaves may wither and drop early. *Control:* Collect and burn infected leaves. Apply zineb, several times, 10 days apart, starting when spotting is first evident.
4. *Downy Mildew* — Widespread. See (6) Downy Mildew under General Diseases.
5. *Root Rots* — See (34) Root Rot under General Diseases.
6. *Mosaic* — See (16) Mosaic under General Diseases.
7. *Stem Nematode* — See under Phlox.

EVERLASTING — See Chrysanthemum

EXACUM — See Gentian

FAGUS — See Beech

FALL-DAFFODIL — See Daffodil

FALSE - ACACIA — See Honeylocust

FALSE - CAMOMILE — See Chrysanthemum

FALSE - DRAGONHEAD — See Salvia

FALSE - GARLIC — See Onion

**FALSE - INDIGO (*Baptisia*); LEADPLANT, INDIGOBUSH (*Amorpha*);
INDIGO (*Indigofera*)**

1. *Leaf Spots* — Widespread. Spots of various sizes, shapes, and colors on the leaves. *Control*: Collect and burn tops in the fall. Apply zineb, maneb, or fixed copper at 7- to 10-day intervals during rainy periods in the spring and early summer.
2. *Powdery Mildews* — Common. White, powdery mold patches on the leaves. *Control*: Apply sulfur or Karathane twice, 10 days apart.
3. *Rusts* — General. Small, yellowish to orange spots and pustules on the leaves. Infected leaves may drop in large numbers. *Control*: Same as for Leaf Spots (above).
4. *Root Rots* — See (34) Root Rot under General Diseases. May be associated with root-feeding nematodes (e.g., burrowing).
5. *Twig Canker* (*amorpha*) — See under Maple.

FALSE - MALLOW — See Hollyhock

FALSE - MESQUITE — See Calliandra

FAREWELL - TO - SPRING — See Fuchsia

FAWN LILY — See Erythronium

FEIJOA — See Myrtle

FELICIA — See Chrysanthemum

FENDLERA — See Hydrangea

FENNEL — See Celery

FERNS: MAIDENHAIR (*Adiantum*); BIRDSNEST, SPLEENWORT (*Asplenium*); LADY, SILVERY SPLEENWORT (*Athyrium*); BLECHNUM; WALKING or WALKINGLEAF (*Camptosorus*); ROCKBRAKE or PARSLEY (*Cryptogramma*); HOUSE HOLLY (*Cyrtomium*); BLADDER, BERRY BLADDER, BRITTLE (*Cystopteris*); HAY - SCENTED or BOULDER (*Dennstaedtia*); LEATHER WOOD or MARGINAL, MALE, MARSH or MEADOW, NARROW BEECH, OAK, SHIELD, TOOTHED WOOD, WOOD, (*Dryopteris*); BARROW, BOSTON, FLUFFY and GREEN RIPPLES, PERSON, SCOTT, SWORD, WHITMAN (*Nephrolepis*); SENSITIVE (*Onoclea*); ADDERSTONGUE (*Ophioglossum*); CINNAMON, INTERRUPTED, ROYAL (*Osmunda*); CLIFFBRAKE (*Pellaea*); COMMON POLYPODY or WALL, HARESFOOT, POLYPODY, RESURRECTION, ROCK POLYPODY (*Polypodium*); CHRISTMAS or DAGGER, GIANT HOLLY, LEATHER HOLLY, PACIFIC CHRISTMAS or WESTERN SWORD (*Polystichum*); AMERICAN OSTRICH or OSTRICH (*Pteretis*); BRACKEN (*Pteridium*); BRAKE or SPIDER (*Pteris*); WOODSIA, ROCK (*Woodsia*); CHAIN (*Woodwardia*)

1. *Anthracnose, Tip Blight* — Growing tips of leaves (fronds) turn brown, shrivel, and die. Plants appear sickly and blighted. *Control:* Remove and burn blighted fronds. Destroy badly infected plants. If possible, avoid sprinkling the foliage. Indoors, regulate the temperature, humidity, and ventilation. Avoid overwatering.
2. *Leaf Spots, Leaf Blight, Tar Spot* — Fronds have spots of various colors and sizes, especially at or near the margins. Spots may be zoned or run together, forming large blotches. Leaves may roll and wither prematurely. *Control:* Same as for Anthracnose (above).
3. *Leaf Nematodes* — Symptoms variable. Reddish-brown to black bands, limited by the leaf veins. Often extend from the center to the margin of a leaf. Or irregular

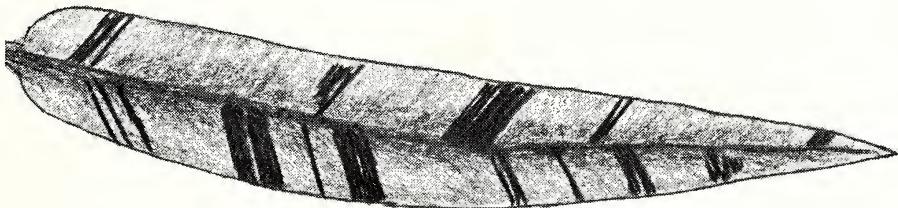


Fig. 117. Leaf nematode of fern.

blotches may occur (Figure 117). On *birdsnest* fern, the base of the frond turns brown. Later the discoloration moves upward. Plants may die. *Control:* Remove and burn infested leaves. Indoors, keep water off the foliage. Birdsnest and similar ferns may be disinfested by immersing the plants in hot water (110° F.) for 10 to 15 minutes.

4. *Rusts* — Primarily an outdoor problem. Reddish-brown to black, powdery pustules, arranged *irregularly* on the fronds. Most common near the alternate hosts (alpine, balsam, grand, noble, Pacific silver, and lowland white firs). *Control:* None usually needed.
5. *Leaf Blisters, Leaf Gall* — Well-marked yellow areas on both leaf surfaces. *Control:* None usually needed. Same as for Anthracnose (above).
6. *Leaf Scorch* — Tips and margins of leaves are scorched. Fronds tend to die back. *Control:* Avoid excessive sun and wind. Plant in a shady spot in natural, moist "woods soil."

7. *Sooty Mold, Black Mildew* — Black mold grows on leaf surface following scale or other insects. *Control:* Destroy insects, using malathion sprays or dips.
8. *Damping-off* — Seedlings (prothallia) become soft and dark and collapse. *Control:* Sow fern spores in a sterile rooting medium such as soil or sifted sphagnum moss.
9. *Inflorescence Smut* (*osmunda*) — See (11) Smut under General Diseases.

FERN, ASPARAGUS or LACE — See Asparagus

FEROCACTUS — See Cactus

FESCUE, FESCUE GRASS (*Festuca*) — See Lawnglass

FETTERBUSH — See Blueberry

FEVERFEW — See Chrysanthemum

**FIG [COMMON, CREEPING, FIDDLELEAF, FLORIDA STRANGLER],
INDIA RUBBER TREE, RUBBER PLANT (*Ficus*);
PAPER - MULBERRY (*Broussonetia*)**

1. *Anthracnose, Leaf Spots, Fruit Rot* — General. Tips and margins of leaves are yellowish, then tan, and finally dark brown and "scorched." Minute pinkish "pimples," sometimes in zones, may be sprinkled in diseased areas. Enlarging, sunken, discolored spots on fig fruit. *Control:* Pick off and burn infected leaves. In a commercial fig-growing area, check with your county agent or extension plant pathologist regarding a suitable spray program. Indoors, avoid sprinkling the foliage. If practical, apply zineb or captan before wet periods.
2. *Leaf Scorch, Leaf Roll, Leaf Fall* — Primarily an indoor problem. Tips and margins of leaves are scorched. Or large blotches occur in the leaves. Affected areas may curl and crack. Leaves drop early. *Control:* Keep the soil at a uniform moisture level. Avoid high room temperatures and exposure to full sun. Do not keep the air too dry. Repot plants using a light, fast-draining potting mixture.
3. *Crown Gall* — See under Begonia, and (30) Crown Gall under General Diseases.
4. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases. May be associated with nematodes (e.g., burrowing, dagger, fig cyst, pin, root-lesion or meadow, ring, root-knot, spiral, stubby-root, stylet or stunt). *Control:* Destroy badly infected indoor plants and replant in sterilized soil (pages 437-44).
5. *Dieback, Canker, Twig Blights, Limb Blight* — See under Maple. Prune plants carefully late in the season and remove all dead branches, cankers, and dried-up fruit. Dip pruning shears in 70 per cent denatured alcohol, 1:1,000 mercuric chloride, or phenyl mercury solution after each cut through a canker. Paint all cuts with tree wound dressing (page 25). Spray as for Rust (below). Protect trees against winter injury. See under Apple.
6. *Fruit Rots, Souring* (fig) — Rot spots of various colors develop in the fruit. Black, gray, or pink mold may grow on affected areas. *Control:* Pick fruit as soon as ripe. Collect and destroy dropped fruit promptly.
7. *Other Leaf Spots, Leaf Blotch, Rusty Leaf* — Spots and streaks of various colors, sizes, and shapes on leaves. Spots may enlarge until the entire leaf is blighted. *Control:* Same as for Anthracnose (above) and Rust (below).
8. *Sooty Mold* — See under Apple, and (12) Sooty Mold under General Diseases.
9. *Rust* (fig) — Numerous small, reddish to brownish spots on underleaf surface. If severe, leaves may turn yellowish-brown and drop early. *Control:* Apply ferbam, fixed copper, or bordeaux mixture at 2- to 3-week intervals.
10. *Root-knot, Fig Cyst Nematode* — A limiting factor in fig production. See under

- Peach, and (37) Root-knot under General Diseases. Fumigate soil with D-D, EDB, Nemagon, Fumazone, or VC-13. Fig species are available which are resistant rootstocks.
11. *Wood Rots* (fig) — See under Birch, and (23) Wood Rot under General Diseases.
 12. *Mosaic* (fig) — Symptoms variable. Leaves may be severely distorted, show irregular, yellowish-green blotches, spots, bands, or yellowish mottling. Fruit may be deformed and spotted. Both fruit and leaves may drop early. Transmitted by grafting and mites. *Control:* Plant virus-free stock. Destroy infected plants when found. Varieties differ considerably in resistance. Check with your county agent or extension plant pathologist.
 13. *Sunscald, Winter Injury* — See under Apple and Elm. Disease organisms get into frost-weakened and sunburned trees. *Control:* Whitewash or wrap trees (page 29).
 14. *Oedema* (rubber plant) — Indoor problem. Corky callus-growths on the petioles and underleaf surface. *Control:* Increase light and temperature and decrease soil moisture, especially in humid weather.
 15. *Fusarium Wilt* (fig) — See (15A) Fusarium Wilt under General Diseases.
 16. *Mistletoe* (paper-mulberry) — See (39) Mistletoe under General Diseases.
 17. *Web Blight, Thread Blight* — Southeastern states in warm, moist weather. White, threadlike, fungus hyphae grow over the underleaf surface killing the leaves, many of which remain hanging on the tree matted together by the spiderweblike fungus threads. See also under Bean. *Control:* Apply one or two sprays of fixed copper or bordeaux. Pruning out of infected branches may be warranted.
 18. *Southern Blight* — See (21) Crown Rot under General Diseases.
 19. *Chlorosis, Zinc and Manganese Deficiency* — See under Walnut.

FIGMARIGOLD — See Iceplant

FILBERT — See Birch

FILIPENDULA — See Rose

FINOCCHIO — See Celery

FIR — See Pine

FIRE - CHALICE — See Evening - primrose

FIRECRACKER PLANT — See Cigarflower

FIRE - PINK — See Carnation

FIRETHORN — See Apple

FIREWHEEL — See Chrysanthemum

FIRMIANA — See Phoenix - tree

FITTONIA — See Silver Threads

FIVE - LEAF or FIVE - FINGERED ARAlia — See Acanthopanax

FLAME VIOLETS — See African - violet

FLANNEL - BUSH — See Phoenix - tree

FLAX, FLOWERING [ANNUAL, BLUE, GOLDEN] (Linum)

1. *Stem Rot, Damping-off* — Seedlings wilt and collapse. Stems rot off at the soil line. May be covered with a cottony mold. *Control:* Treat seed with captan, thiram, or chloranil. Avoid overwatering, overcrowding, and planting in poorly drained soil.

Dig up and burn older, dying plants together with several inches of surrounding soil.

2. *Root-knot* — See under Bean, and (37) Root-knot under General Diseases.
3. *Curly-top* — See (19) Curly-top under General Diseases.

FLEABANE, FLORAS - PAINTBRUSH — See Chrysanthemum

FLORIDA YELLOWTRUMPET — See Trumpettree

FLOWERING ALMOND — See Peach

FLOWERING CRABAPPLE — See Apple

FLOWERING CurrANT — See Currant

FLOWERING MAPLE — See Hollyhock

FLOWERING QUINCE — See Apple

FLOWERING TOBACCO — See Tomato

FLOWER - OF - AN - HOUR — See Hollyhock

FOAMFLOWER — See Hydrangea

FOENICULUM — See Celery

FOGFRUIT — See Lantana

FORESTIERA — See Ash

FORGET - ME - NOT — See Mertensia

**FORSYTHIA [EARLY, GOLDENBELLS, KOREAN, SPRING GLORY, WEEPING]
(*Forsythia*)**

1. *Leaf Spots, Anthracnose* — Small to large, grayish, yellow, or brown spots on the leaves. *Control:* Pick off and burn infected leaves. If necessary, apply zineb or maneb several times, 10 days apart.
2. *Twig or Cane Blight, Dieback, Southern Blight, Blossom Blight* — Blossoms turn brown. Twigs wither and die back from girdling cankers or a crown rot. A dense cottony mold may grow over the plant near the soil line. *Control:* Prune and burn infected twigs. Keep the soil surface at the crown loose and dry. Applying Terraclor (PCNB) as a dust or spray to the crown may help. See under Bean, White Mold.
3. *Bacterial Blight* — Shoots and entire branches may blacken and die. Brown stain in the wood. Often throughout a whole branch. *Control:* See under Lilac.
4. *Stem Gall* — Round to irregular, bumpy overgrowths along the stems. Stems unsightly in winter. May die back. *Control:* Cut off and burn infected branches.
5. *Crown Gall* — See under Apple, and (30) Crown Gall under General Diseases.
6. *Root-knot* — Forsythia is quite susceptible. See (37) Root-knot under General Diseases.
7. *Root Rot* — See (34) Root Rot under General Diseases. May be associated with root-feeding nematodes (e.g., dagger, ring, root-knot, stem, stylet or stunt).

FORTUNELLA — See Citrus

FOUR - O'CLOCK [COMMON, COLORADO] (*Mirabilis*); TRAILING FOUR - O'CLOCK (*Allionia*); SAND - VERBENA (*Abronia*); UMBRELLAWORT (*Oxybaphus*)

1. *Rusts* (four-o'clock, sand-verbena, trailing four-o'clock) — Southwestern states. Small, yellow or yellowish-orange spots on the leaves. Alternate hosts may include wild grasses (*Aristida* and *Distichlis*). *Control:* If serious, apply zineb or maneb about 10 days before rust normally appears. Repeat sprays at 10-day intervals.
2. *White-rust* — Pale yellow spots on the upper leaf surface with white pustules on the corresponding underside. *Control:* Collect and burn tops in the fall or spotted leaves as they appear. Spray as for Rusts (above).
3. *Leaf Spots* — Small and indistinct or round, pale brown to tan spots, with dark borders, on the leaves. *Control:* Pick off and burn spotted leaves. Spray as for Rusts (above).
4. *Root-knot* — See under Bean, and (37) Root-knot under General Diseases.
5. *Curly-top* (four-o'clock) — Western states. See under Beet, and (19) Curly-top under General Diseases.
6. *Root Rot* — See (34) Root Rot under General Diseases.
7. *Downy Mildew* (four-o'clock, sand verbena, trailing four-o'clock, umbrellawort) — See (6) Downy Mildew under General Diseases.

FOXGLOVE — See **Snapdragon**

FRAGARIA — See **Strawberry**

FRAGRANT GLAD — See **Gladiolus**

FRAGRANT PINK — See **Carnation**

FRAGRANT STOCK — See **Cabbage**

FRAGRANT VIBURNUM — See **Viburnum**

FRANGIPANI — See **Oleander**

FRANKLIN - TREE, LOBLOLLY - BAY (*Franklinia, Gordonia*)

1. *Leaf Spot* — Small spots on leaves. *Control:* If serious enough, spray with zineb, maneb, or fixed copper in wet seasons.
2. *Black Mildew* — Southern states. Black, moldy spots or blotches on the leaves. *Control:* Same as for Leaf Spot (above). Control insects with malathion sprays.
3. *Root Rot* — See (34) Root Rot under General Diseases.

FRASERA — See **Gentian**

FRAXINUS — See **Ash**

FREESIA — See **Gladiolus**

FREMONTIA — See **Phoenix-tree**

FRENCH-MULBERRY — See **Lantana**

FRINGETREE — See **Ash**

FRITILLARIA, FRITILLARY — See **Tulip**

FROELICHIA — See **Cockscomb**

FROSTWEED, FROSTWORT — See Sun-rose**FUCHSIA; ROCKY MOUNTAIN GARLAND (*Clarkia*); BOISDUVALIA, SPIKE-PRIMROSE (*Boisduvalia*); FAREWELL-TO-SPRING, SATIN-FLOWER (*Godetia*)**

1. *Rusts* — Pale spots on the upper leaf surface and yellowish-orange or brown to black, powdery pustules on the lower leaf surface. Lower leaves may shrivel and die. *Control*: Pick off and burn infected leaves. If serious enough, apply zineb, ferbam, maneb, or dichlone at weekly intervals.
2. *Gray-mold Blight, Stem Canker* — Leaves blighted and covered with a dense gray mold. See (5) Botrytis Blight under General Diseases. *Control*: Avoid overcrowding. Increase air circulation and reduce humidity.
3. *Verticillium Wilt* — See (15B) Verticillium Wilt under General Diseases.
4. *Root-knot* — See under African-violet, and (37) Root-knot under General Diseases.
5. *Root Rots* — Plants may wilt suddenly and die within a few days. See (34) Root Rot under General Diseases.
6. *Spotted Wilt* — See under Begonia, and (17) Spotted Wilt under General Diseases.
7. *Damping-off* — Seedlings collapse from a rot at the soil line. *Control*: Grow seedlings in sterilized soil (pages 437-44) or in a sterile medium.
8. *Clarkia Stem Rots, Fusarium Wilt* — See under Chrysanthemum.
9. *Aster Yellows, Curly-top* (*clarkia, godetia*) — See under Chrysanthemum.
10. *Downy Mildew* (*clarkia, godetia*) — See under Chrysanthemum.
11. *Leaf Spots, Anthracnose* (*clarkia*) — See under Chrysanthemum.

FURCRAEA — See Centuryplant**GAILLARDIA — See Chrysanthemum****GALANTHUS — See Daffodil****GALAX; OCONEE-BELLS (*Shortia*)**

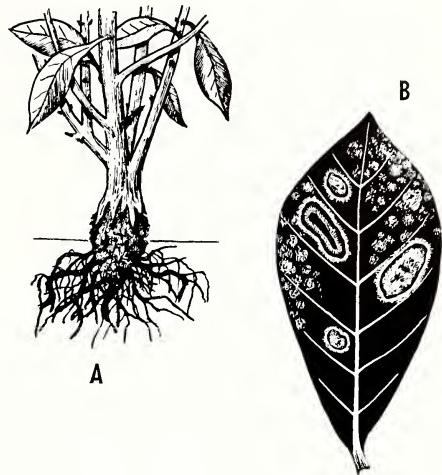
1. *Leaf Spots* — Small to large, round to irregularly lobed spots and blotches on the leaves. Leaves may wither and die early. *Control*: Pick off and burn spotted leaves. Do not syringe plants. If needed, spray several times at weekly intervals. Use zineb, maneb, or dichlone.

GALIUM — See Buttonbush**GALTONIA — See Tulip****GARDEN BALSAM — See Balsam****GARDEN CRESS — See Cabbage****GARDEN-HELIOTROPE (*Valeriana*) — See Valerian****GARDEN HUCKLEBERRY — See Blueberry****GARDEN VERBENA — See Lantana****GARDENIA, CAPE-JASMINE (*Gardenia*)**

1. *Stem Canker or Gall* — Widespread. Primarily an indoor problem. Leaves dwarfed, wilt, shrivel, turn yellow and fall early. Flower buds are blasted and fall before opening. Oblong, sunken to swollen, brown cankers form on the branches and at the crown. May girdle affected parts causing stunting and death. Crown cankers

appear as corky overgrowths (swollen, cracked ridges). See Figure 118A. *Control:* Buy disease-free plants or take tip cuttings from healthy plants. Use a sharp knife. Avoid injuring plants. Remove cankers on branches by cutting stems 3 inches back of the cankers. Swab cuts immediately with 70 per cent denatured alcohol. Remove and burn severely infected plants. Keep water off the foliage. Place new plants in another location. Dip cuttings in ferbam (2 tablespoons per gallon), Semesan, or

Fig. 118. A. Stem canker of gardenia, B. Leaf spots of gardenia.



phenyl mercury solution (1 ounce in 5 gallons) for 5 minutes before sticking. Use a pasteurized rooting medium (pages 437-44). Spray stems and crowns weekly using zineb or ferbam. Veitchii is more resistant to Phomopsis Canker than Belmont or Hadley.

2. *Fungus Leaf Spots* — Round to oval spots, sometimes zoned. Mostly on the lower leaves following wet weather. Leaves may die. See Figure 118B. *Control:* Pick off and burn infected leaves. Space plants. Avoid sprinkling water on the foliage and wounding leaves. Spray foliage as for Stem Canker (above). Use disease-free plants for propagation. Varieties differ in resistance.
3. *Bacterial Leaf Spot* — Small to large, round to angular, brown or reddish-brown spots on the leaves, surrounded by a narrow, water-soaked or yellowish border. Leaves may turn yellow and drop early, starting at the base of the plant. *Control:* Same as for Fungus Leaf Spots (above). Plant only disease-free cuttings. Sterilize soil and containers before planting. See "Soil Treatment Methods and Materials" in the Appendix.
4. *Bud Rot, Bud Drop* — Buds may turn pale green or yellow, often soften, darken, and drop. Flower stalks may be discolored. *Control:* Same as for Fungus Leaf Spots (above). Indoors, avoid large temperature fluctuations, overwatering, and dry or extremely humid air. Add daytime lights during overcast periods. The temperature should be about 62° to 65° F. at night and above 70° F. during the day. Pick off and burn affected buds. Increase humidity in the home.
5. *Root-knot* — Widespread in southern states and northern greenhouses. Gardenia is highly susceptible. Leaves may wilt during the day; fall prematurely. Plants may be stunted with sickly, mottled leaves. *Control:* Dig up and burn infested plants. Plant in sterilized soil. *Gardenia thunbergia* is a resistant rootstock.

6. *Gray-mold Blight, Botrytis Petal Blight* — Numerous, light brown spots on the petals which enlarge and run together forming blotches. A gray mold may grow on infected tissues in damp weather. Buds may drop early. *Control:* Same as for Fungus Leaf Spots (above). Carefully pick off and burn blighted flowers and buds. If practical, spray blooms at 2- or 3-day intervals in damp weather using a fine mist of captan or zineb (1 tablespoonful per gallon of water).
7. *Chlorosis* — Widespread. Leaves are stunted and pale green or yellowish between the veins. Young leaves may turn yellow, die, and fall early. Plants make poor growth. Tips may die. See Figure 79. *Control:* Plant in light, well-drained, slightly acid soil. Have the soil tested if in doubt. Keep plants free of Stem Canker and Root-knot. Have the soil above 60° F. Spray plants monthly with iron sulfate, 1 tablespoon per gallon of water. Or apply iron chelate (or iron sulfate) to the soil in water solution. Follow the manufacturer's directions.
8. *Sooty Mold* — Very common in the Gulf States following attacks by scales, white-flies, mealybugs, and other insects. Crusty black coating forms on leaves and stems. *Control:* Wash off the sticky coating. Apply malathion to control insects.
9. *Powdery Mildew* — See (7) Powdery Mildew under General Diseases.
10. *Root Rot* — See (34) Root Rot under General Diseases. Often associated with nematodes (e.g., burrowing, dagger, lance, needle, pin, reniform, ring, root-lesion, spiral, stubby-root, stylet or stunt).
11. *Dieback* — Indoor problem. Branches die back. Leaves wither and fall off. *Control:* Avoid overwatering. Plant in well-drained soil.
12. *Crown Gall* — See (30) Crown Gall under General Diseases.

GARLAND FLOWER — See Daphne

GARLIC — See Onion

GARRYA — See Dogwood

GAULTHERIA — See Heath

GAYFEATHER — See Chrysanthemum

GAYLUSSACIA — See Blueberry

GAZANIA — See Chrysanthemum

GELSEMIUM — See Butterflybush

GENISTA — See Broom

GENTIAN [CLOSED, FRINGED, NARROW-LEAVED]
(*Gentiana*); PRAIRIEGENTIAN, TEXAS-BLUEBELL (*Eustoma*);
EXACUM; COLUMBO (*Frasera*)

1. *Leaf Spots, Leaf Blotch* — Spots of various colors, shapes, and sizes on the leaves. If severe, leaves may wither. *Control:* Pick off and burn spotted leaves. Spray at 10- to 14-day intervals during wet periods, using zineb, maneb, or fixed copper.
2. *Botrytis Blight, Stem Canker* (gentian, exacum) — Light brown spots or blotches on the leaves with darker margins. Cankers may form on the stems. A gray mold often covers infected areas in damp weather. *Control:* Remove and destroy infected parts. Space plants. Spray as for Leaf Spots (above).
3. *Rusts* (columbo, gentian) — Yellow spots on the lower leaves. Spots may later turn into reddish-brown, dark brown, or black powdery pustules. Disease moves upward as the season progresses. *Control:* Destroy infected plants. Spray remainder as for Leaf Spots (above).

4. *Root and Crown Rot, Damping-off* — Seedlings wilt and collapse. Older plants rot at the base. Roots often decay. *Control:* Plant in clean, well-drained soil. Rotate. Avoid overwatering and wounding stems and roots.
5. *Stem Blights* (prairiegentian) — See (22) Stem Blight under General Diseases. *Control:* Spray as for Leaf Spots (above). Add malathion to control mealybugs and other insects.
6. *Black Mildew* (columbo) — See (12) Sooty Mold under General Diseases.

GERANIUM [FISH, FLORISTS', IVY, LADY WASHINGTON, NUTMEG, ROSE, STORKSBILL] (*Pelargonium*) (See also Cranesbill)

1. *Blackleg, Stem and Cutting Rots* — Cosmopolitan. Leaves turn yellow or reddish and drop. Plants stunted. Die gradually. Base of cutting or stem is soft, brown, and water-soaked. Soon blackens, shrivels, and may turn slimy. Rot works upward from the soil line until plant wilts and dies. See Figure 37D under General Diseases. *Control:* Take only tip cuttings from disease-free plants sprayed 30, 20, and 10 days before taking cuttings. Use ferbam, zineb, or captan (1½ tablespoons per gallon of water). Plant in a sterile medium (pages 437-44). Avoid overcrowding, overwatering, or sprinkling water on the foliage. Sterilize cutting knife and other tools by dipping in a 1:1,000 solution of mercuric chloride or 70 per cent denatured alcohol between cuts. Keep down the humidity and increase the air circulation. Separate healthy from diseased plants. If rot starts in the cutting bed, remove infected plants or plant parts and apply zineb as a soil drench (2 tablespoons per gallon of water). Destroy infected plants when first discovered.
2. *Root Rots* — Leaves, especially the lower ones, turn yellow, wilt, die, and then fall off. New shoots are pale green and sickly. Flowering is reduced. Or blossoms fall soon after opening. Roots are brown or black and rotted. May be associated with nematodes (e.g., pin, root-knot, root-lesion, spiral, stem, stubby-root, stylet). *Control:* Same as for Blackleg (above).
3. *Crinkle, Mosaic, Mottle, Leaf Curl, Leaf Breaking, Spotted Wilt, Ringspots, Curly-top (Leaf Cupping?)*. — General. A virus complex producing variable symptoms which may disappear in hot weather. Leaves may be stunted, ruffled, crinkled, cupped inward, puckered, and dwarfed. Small, round to irregular, pale yellow to white, red or purple spots, rings or arclike patterns may appear on the leaves. Or leaves may be mottled with light and dark green areas. Normal leaf patterns tend to disappear. Leaves may turn yellow and drop early. Symptoms are most apparent on young leaves in cool weather. Plants stunted, may appear bushy. Flowering is reduced. *Control:* Take tip cuttings only from known virus-free plants. Discard plants which look suspicious. Varieties differ greatly in apparent resistance. Control insects and mites using malathion.
4. *Fungus Leaf Spots, Blossom Blight, Gray-mold Blight* — Cosmopolitan. Small to large, round to irregular, spots on the leaves which are water-soaked, light brown to tan, reddish-brown or dark brown in color. Spots may enlarge and run together killing the leaf. Flower petals may discolor, fade, and wilt. Flowers fall prematurely. Affected parts may later be covered with an olive-green, gray, dark brown, or black mold. See figures 19A and 45C under General Diseases. *Control:* Same as for Blackleg (above). Pick off and burn infected leaves and blossoms. Apply captan, zineb, maneb, or fixed copper during damp periods.
5. *Bacterial Stem Rot (Wilt) and Leaf Spots* — Often a limiting factor in production. Small, dark green, water-soaked blisters on the leaves. Mostly on underleaf surface. Spots enlarge, and often run together becoming angular with centers sunken and brown. May resemble "frogeyes." Leaves may turn yellow, wither, and fall. Infected stems are dull blackish-brown and shriveled with a semidry rot. Cuttings

rot progressively upwards from the base. *Control:* Same as for Blackleg (above). Destroy infected leaves. Varieties differ in resistance. Avoid forcing plants too rapidly, especially during warm, humid weather. Space plants. Maintain balanced fertility.

6. *Oedema, Dropsy* — Common indoor problem. Small, water-soaked leaf spots which later become reddish-brown, corky, and raised. Mostly on larger leaf veins but also occur on stems and petioles as corky ridges. Leaves may turn yellow and drop early. *Control:* During overcast, humid weather avoid overwatering. Lower the humidity and increase heat and light. Space plants. Avoid low potassium and calcium levels in the soil.
7. *Root-knot* — Plants may be sickly and weak from small galls on the roots. *Control:* Destroy infested plants and grow new plants in sterilized soil. See pages 437-44 in the Appendix. Start with tip cuttings.
8. *Verticillium Wilt* — Lower leaves turn yellow at the margins and wilt. Wilt later progresses up the stem. Plants may be stunted. *Control:* Destroy infected plants. Take only tip cuttings from healthy plants. Then treat as for Blackleg (above).
9. *Crown Gall* — Common but not very damaging. Cauliflowerlike galls or knots formed on the roots and crown. Growth is checked. *Control:* Take cuttings from healthy plants. Grow plants in sterilized soil. Avoid wounding stems.
10. *Leafy Gall, Fasciation* — Plants stunted. Clusters of small, malformed shoots form near the soil line. May closely resemble Crown Gall. See Figure 42B under General Diseases. *Control:* Same as for Crown Gall (above).
11. *Leaf Nematode* — See (20) Leaf Nematode under General Diseases.

GERBERA, GERMAN CAMOMILE — See Chrysanthemum

GERMANDER — See Salvia

GERMAN IVY — See Chrysanthemum

GESNERIA — See African - violet

GEUM — See Rose

GHERKIN, WEST INDIAN — See Cucumber

GIANT DAISY — See Chrysanthemum

GIANT WHITE NIGHT BLOOMER — See Morning - glory

GILIA — See Phlox

GINKGO, MAIDENHAIR - TREE (Ginkgo)

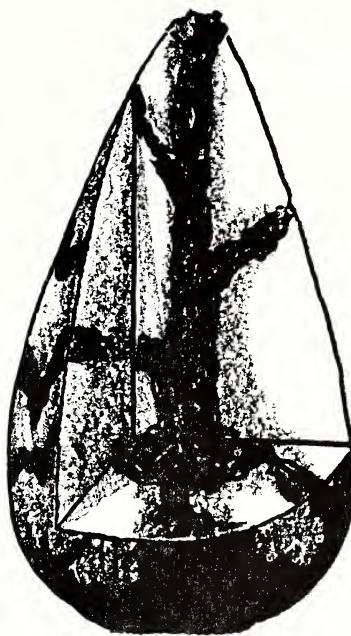
1. *Leaf Spots, Anthracnose* — Uncommon. Yellow to brownish spots on the leaves. Leaves may turn yellow. *Control:* See Leaf Spots under Maple.
2. *Root-knot* — See under Peach, and (37) Root-knot under General Diseases.
3. *Wood Rots* — See under Birch, and (23) Wood Rot under General Diseases.
4. *Root Rot* — See (34) Root Rot under General Diseases.

**GLADIOLUS [COMMON, MINIATURE, NIGHT - BLOOMING] (*Gladiolus*);
FRAGRANT GLAD (*Acidanthera*); COPPER - TIP (*Crocosmia*); CROCUS
[SAFFRON, SPRING] (*Crocus*); FREESIA; IXIA; TIGERFLOWER, AZTEC LILY,
SHELL FLOWER (*Tigridia*); MONTBRETIA (*Tritonia*)**

1. *Corm and Bulb Rots, Crown Rot, Southern Blight, Flower Blights, Wilt, Yellows* — General and serious. Leaves pale, turn yellow, wither, and die back from rotting

of crown or underground parts. Corm (or bulb) shows round to irregular, tan, yellowish-brown, reddish-brown, dark brown or black rotted areas which may be somewhat sunken. The whole corm may rot, becoming a dry, brownish-black "mummy." The rot often spreads up into the leaves which darken and rot at their bases. Infected corms continue to rot in storage, but may show no symptoms at the time of digging. A bluish-green, gray, black, or cottony mold growth may

Fig. 119. Freesia corm rot.



develop on rotted areas during storage. Flowers may be spotted and blighted. See Figure 47C under General Diseases and Figure 119. *Control:* Plant only best quality, disease-free corms in sterilized soil (pages 437-44) or where disease has not occurred before. Grow in a sunny spot where air circulation is good. Avoid low, wet spots. Fertilize well with potassium and phosphorus but keep nitrogen on the low side. Dig and destroy infected plants as they occur. Gladiolus varieties differ greatly in resistance. Handle corms carefully to prevent bruising. Harvest corms (or bulbs) early, shake off loose soil, and cure rapidly at 75° to 90° F. with good ventilation, for 1 to 2 weeks. Then remove tops and roots and dust corms thoroughly with thiram. Before treatment, sort and discard those showing rot spots. When treating, shake corms and dust together in a tight paper sack. For each quart of corms use an amount of dust at least equal in quantity to an aspirin tablet. If using a dip, soak *gladiolus* corms in a 1:1,000 solution of mercuric chloride for 2 hours, New Improved Ceresan (1 tablespoon per gallon) for 15 minutes, or use Emmi or liquid Ceresan, following the manufacturer's directions. Certain varieties may be injured by these mercury treatments. Use with caution. Or soak dormant *gladiolus* cormels, kept in a warm dry room, in hot water (135° F.) for 30 minutes. This treatment may reduce sprouting. Store corms over winter in a well-ventilated, cool (35° to 40° F. location with low humidity (about 75 per cent). Applying Vapam, V.P.M. Soil Fumigant, or chloropicrin as a furrow or broadcast treatment, several weeks before planting, has proved beneficial. Follow

the manufacturer's directions. Terraclor applied in the open furrow at planting time has given good control of *Stromatinia* (*Sclerotinia*) Rot. Use $\frac{1}{2}$ pound of 20 per cent dust for 22 feet of row. Keep down weeds. Burn all plant debris in the fall. In humid areas, spray as for Leaf Spots (below).

2. *Bacterial Scab, Neck Rot, Bacterial Leaf Spot* — General in warm wet weather. pale yellow to brownish-black, varnish-like spots or streaks form on the husks. Corm tissue underneath shows round, yellowish to tan, water-soaked spots which later become brownish-black, sunken, scabby, and gummy. Leaf bases (neck) may rot and the top collapses. Scabby corms are associated with bulb mites. Small, more or less round, reddish-brown, water-soaked leaf spots may enlarge and run together forming large dead blotches. Leaves may turn yellow at the tips and die prematurely. See Figure 120. *Control*: Same as for Corm Rots (above). Plant only scab-free corms. Apply a soil insecticide (e.g., aldrin, dieldrin, or heptachlor)

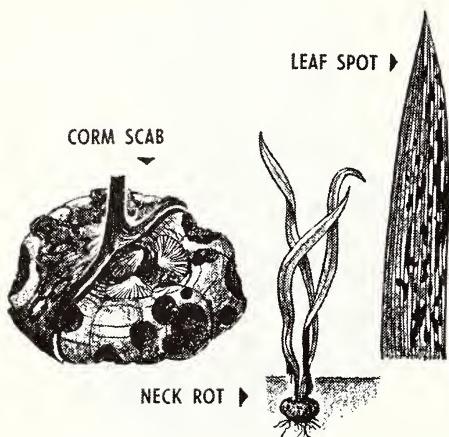


Fig. 120. Bacterial scab of gladiolus.

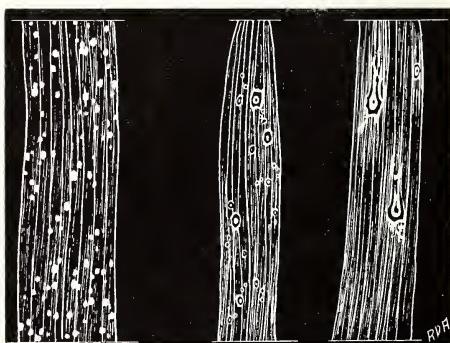


Fig. 121. Gladiolus leaf spots.

in the furrow before planting to control wireworms, other soil insects, and bulb mites.

3. *Bacterial Leaf Blight* — May be serious in wet seasons. Water-soaked, dark green leaf spots which later turn brown. Spots become gummy and square or rectangular in shape. Leaves appear scorched. May die. Spots restricted to between the leaf veins when young. Younger plants most severely attacked. *Control*: Soak corms in a mercury-containing solution. See Corm Rots (above).
4. *Leaf Spots, Flower Spots or Blights* — General. Small, round to elongated or irregular spots of various colors — tan, yellow, brown, purplish-brown or black — some with one or more dots or mold growth in the center. Leaves may turn yellow, wither, and die back from the tips. Plants may not bloom. Corm size and production is often decreased. Spots also may occur on the corms, stems, bud sheaths, and flower petals. See Figure 45B under General Diseases, and Figure 121. *Control*: Same as for Corm Rots (above). Spray weekly during moist weather using zineb, maneb, or captan plus spreader-sticker. Start when leaves are 6 to 10 inches tall or when disease first appears. Varieties differ in resistance. Destroy tops after flowering. Commercial growers often dip flower spikes in a phenyl mercury solution, plus wetting agent, before shipping.
5. *Mosaics, White Break* — Widespread. Plants may be stunted with mild to severe yellowish-green, spotted, mottled, or striped leaves. Infected plants may bloom

early with flower petals crinkled, deformed, and streaked, striped, or flecked with whitish, yellowish, or greenish blotches. See (16) Mosaic under General Diseases. One virus (Tobacco Ringspot) may be spread by cutting shears in harvesting flowers and corms or bulbs. *Control:* Dig and burn infected plants when first found. Keep down weeds. Control aphids which transmit the viruses. Use malathion. Plant virus-free corms or bulbs. Disinfect shears after cutting suspicious flowers or tops.

6. *Aster Yellows, Grassy-top* — Symptoms greatly variable. Young leaves may turn yellowish-green and be twisted. Flower spike may be spindly, green, and twisted. Plants may mature and die early. Often produce small corms and no color in the flowers. *Control:* Same as for Mosaics (above). Control leafhoppers which transmit the virus, using DDT and malathion at about weekly intervals.
7. *Root Rot, Neck or Collar Rot* — Plants may wilt, collapse, and die. Easily pulled up. Leaf bases and roots are often rotted under wet soil conditions. Plants often killed out in a section of row. May be associated with nematodes (see below). *Control:* Same as for Corm Rots (above). A soil drench of Terraclor or Botran (Upjohn) plus Nemagon or Fumazone in infested areas may help. Start when disease is first evident.
8. *Root-feeding Nematodes* (e.g., pin, root-knot, root-lesion, sheath, spiral, summer crimp) — Plants may be sickly and stunted with discolored, stubby roots. Roots may show small, knotlike galls (Root-knot). *Control:* Soak *gladiolus* corms 4 hours in hot water (110° F.) plus 0.5 per cent formalin, or plant disease-free, high-quality corms in clean or sterilized soil. Drenching over the row using Nemagon or Fumazone has also proved beneficial.
9. *Bulb Nematode* (*gladiolus*, *tigridia*) — See (38) Bulb Nematode under General Diseases.
10. *Blind Buds* (*crocus*) — Flower buds do not grow, but dry up or rot. *Control:* Water during dry periods. Avoid excessive heat after harvest and in storage.
11. *Smut* (*gladiolus*) — Rare. Elongated, black, powdery blisters or stripes in leaves, stems, and corms. Seedlings may shred and die early. *Control:* Same as for Corm Rots (above). Destroy infected plants when first found. Soak corms as for Root-feeding Nematodes (above).
12. *Chlorosis* — Plants a sickly yellowish-green, yellow, or ivory color. Plants often stunted. *Control:* Have the soil tested. It should be near neutral. Spray plants with iron sulfate (1 teaspoon per gallon). May apply with regular pest sprays when first noticed. Repeat as necessary.

GLEBITSIA — See Honeylocust

GLOBE - AMARANTH — See Cockscomb

GLOBE ARTICHOKE — See Lettuce

GLOBEFLOWER — See Anemone

GLOBEMALLOW — See Hollyhock

GLOBETHISTLE — See Chrysanthemum

GLOBE LILY, GLOBE - TULIP — See Mariposa Lily

GLORYBOWER — See Lantana

GLORY - OF - THE - SNOW — See Tulip

GLORYVINE — See Grape

GLOWING GOLD — See Pea

GLOXINIA — See African - violet

GOATSBEARD — See Rose

GODETIA — See Fuchsia

GOLDDUST — See Cabbage

GOLDDUST - TREE — See Aucuba

GOLDEN - ASTER — See Chrysanthemum

GOLDENBELLS — See Forsythia

GOLDENCHAIN, BEANTREE, SCOTCH LABURNUM (*Laburnum*)

1. *Leaf Spots* — Round to irregular, light gray, grayish-brown, or brown spots on the leaves. Black dots or mold growth may dot the center of older spots. *Control*: If serious enough, apply zineb, maneb, or fixed copper sprays at 10- to 14-day intervals during rainy weather.
2. *Twig Blight* — In wet springs, brown areas may develop on the twigs which cause the leaves beyond to be blighted. *Control*: Prune out and burn infected twigs. Spray as for Leaf Spots (above).
3. *Mosaic, Infectious Variegation* — Leaves mottled light and dark green. Often brightly variegated. Leaf veins may be yellow and stand out prominently. Growth of tree is apparently normal. *Control*: Spray or dust with malathion or lindane to control aphids which probably transmit the virus. Propagate only from mosaic-free plants.
4. *Root Rot* — See under Apple, and (34) Root Rot under General Diseases.
5. *Root-knot* — See (37) Root-knot under General Diseases.

GOLDENEGBS — See Evening - primrose

GOLDEN ELDER — See Snowberry

GOLDENGLOW — See Chrysanthemum

GOLDENLARCH — See Larch

GOLDEN MARGUERITE — See Chrysanthemum

GOLDEN - PEA — See Pea

GOLDENRAIN - TREE (*Koelreuteria*)

1. *Coral Spot, Twig Canker* — Coral-red cankers on twigs. Affected parts wither and die back. *Control*: Prune out and burn blighted parts. Keep trees vigorous by fertilizing and watering during dry periods.
2. *Verticillium Wilt* — See under Maple, and (15B) Verticillium Wilt under General Diseases.
3. *Leaf Spot* — Small, tan to gray spots on the leaves. *Control*: None necessary.

GOLDEN ROSE OF CHINA — See Rose

GOLDEN - SHOWER — See Honeylocust

GOLDENTUFT — See Cabbage

GOLDEN - WAVE — See *Chrysanthemum*

GOLDFLOWER — See *St. - Johns - wort*

GOLDTHREAD — See *Delphinium*

GOMPHRENA — See *Cockscomb*

GOOSEBERRY — See *Currant*

GORDONIA — See *Franklin - tree*

GORUDS — See *Cucumber*

GRAMATOPHYLLUM — See *Orchids*

GRAPE [**BIRD, CALIFORNIA, CANYON, FOX, FROST or RIVERBANK, EUROPEAN WINE, MUSCADINE, POSSUM, SAND, SUMMER or PIGEON, SWEET WINTER, and WINTER**], **GLORYVINE** (*Vitus*); **PEPPERVINE, MONKSHOOD - VINE, TURQUOISE or PORCELAIN BERRY** (*Ampelopsis*); **MARINE - IVY, GRAPE IVY, KANGAROO VINE** (*Cissus*); **IVY** [**BOSTON, ENGLEMANN**], **VIRGINIA - CREEPER or WOODBINE, PLUME HYACINTH** (*Parthenocissus*)

1. **Black Rot, Leaf Spot** — Widespread. Small, more or less circular to angular, reddish-brown spots on the leaves. Spots usually have dark brown margins and black specks in the centers. Tan-colored spots on grapes which become sunken and surrounded with a dark ring, giving a "bird's-eye" effect. The rot later turns brownish-black and enlarges. The berry rots and usually turns into a hard, shriveled, wrinkled, black mummy. Such fruits drop early. Several or all of the berries in a cluster may become infected (Figure 122). Blossoms are blasted. **Control:** Prune and retie grape vines annually. Burn prunings. Space plants. Keep down weeds. In humid areas, apply captan, zineb, ferbam, thiram, or ziram following the grape spray schedule in the Appendix (Table 10). Check with your county agent or extension plant pathologist regarding timing of sprays for your area. Resistant *grape* varieties: Beta, Campbell Early, Champion, Cimarron, Clinton, Delaware, Diamond, Dracut Amber, Eaton, Elvira, Everglades, Lucile, Lutie, Missouri Riesling, Moore Early, Norton, Steuben, Tarheel, Topsail, and Worden. Check with your county agent or extension horticulturist regarding the adaptability of these varieties to your area. Cultivate in early spring to cover old fruit mummies, leaves, and other plant debris.
2. **Downy Mildew** — Widespread. Greenish-yellow blotches on the upper leaf surface, which later turn reddish-brown. A dense, white, downy mold grows on the corresponding underleaf surface. Fruits, shoots, and tendrils are also attacked. Affected leaves and fruit may drop early. Flower clusters and young berry clusters may be killed. Shoot growth is stunted. See Figure 20A under General Diseases. **Control:** Same cultural practices as for Black Rot (above). Resistant *grapes*: Clinton, Concord, and Lutie. Where downy mildew is a problem apply fixed copper, zineb, or possibly maneb following the grape spray schedule in the Appendix (Table 10). Cover underleaf surface thoroughly. Start when mildew is first seen. Repeat at about 2-week intervals. Collect and burn fallen leaves.
3. **2,4-D Injury** — Cosmopolitan. Leaves, tendrils, and young shoots are misshapen. Leaves have many sawtooth edges and close yellow veins. May appear narrow, fan-shaped, and stiff (Figure 123). Fruits ripen unevenly, if at all. Symptoms likely 1 to 3 weeks after exposure to fumes or spray drift (up to a mile or more). **Control:** Use only the *amine* form of 2,4-D, at low pressure, near grape, tomato, and other garden plantings. Apply to lawns in the fall. Apply only when air movement is

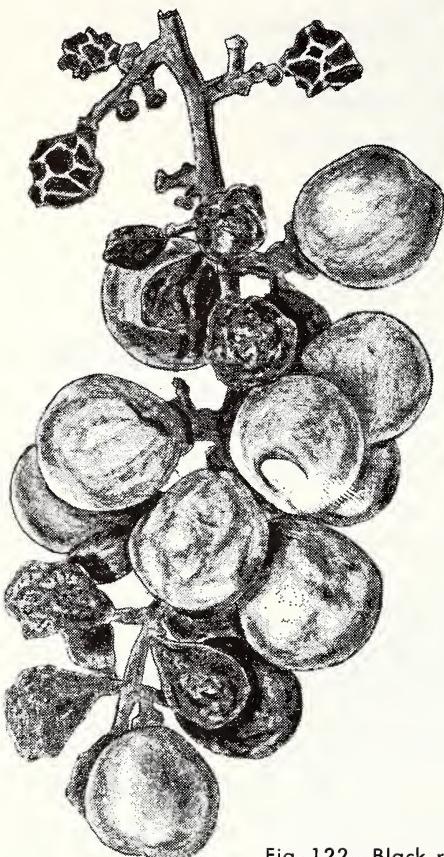


Fig. 122. Black rot of grape.

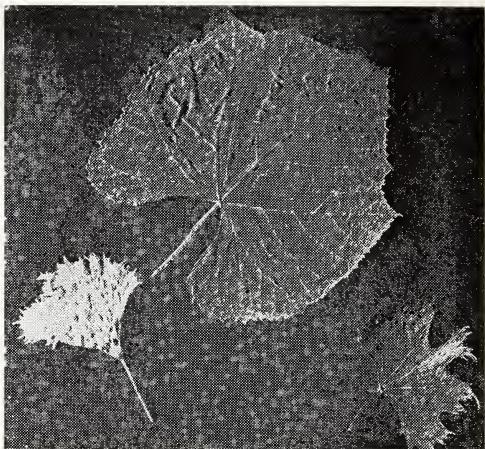


Fig. 123. 2,4-D injury of grape. (Iowa State University photo)

away from grapes and other susceptible plantings. Use a separate sprayer for applying weed killers.

4. *Grape Fruit Rots, Fly Speck* — Widespread in rainy weather. Ripening fruits rot. May be covered with gray, black, bluish-green, green, or pink mold growth. *Control:* Handle fruit carefully. Store fruit as cool and dry as practical. Prune and tie grape vines annually. Destroy rotting fruit. Spray as for Downy Mildew (above). Apply captan alone just before harvest.
5. *Powdery Mildew* — General, especially from midsummer on. Indistinct or thin, powdery, flourlike patches on leaves, shoots (canes), tendrils, blossoms, and young fruit which may later turn brown or black. If severe, may cause stunting, yellowing, and withering. Berries may be dwarfed, distorted, russeted, and cracked. Such fruit may fail to ripen or "shell off" the vine before harvest. Mildew tends to build up following extended use of captan sprays. *Control:* Spray with fixed copper as for Downy Mildew. If serious enough, add Karathane to 2 consecutive sprays. Keep down weeds. Same cultural practices as for Black Rot (above). Resistant or tolerant grapes: Clinton, Delaware, Dutchess, Early Niabell, Elvira, Ives, Niabell, and Royalty.
6. *Grape Dead Arm, Fruit Rot* — Widespread. Locally severe in certain areas. Young

shoots, trunks, and branches may be weakened and killed by perennial, reddish-brown to purplish-black, elongated cankers. Cankers enlarge (often become irregular, black, and crusty), and girdle the trunk or "arm." Portion beyond dies. Leaves on cankered canes are often dwarfed, yellowish, rolled, tattered and "crimped," especially along the edges. Such leaves usually drop early. Leaves which appear late in the season are stunted but otherwise appear normal. Suckers often form at the base of killed spurs giving vines a bushy appearance. Fruit may rot. *Control:* Annually prune out and burn all dead and cankered (blighted) wood at least 6 inches below any sign of disease. Disinfect between cuts, in diseased vineyards, by dipping shears in 70 per cent denatured alcohol. Follow the spray program as for Black Rot and Downy Mildew (both above). Where common, apply a captan spray when new shoots are $\frac{1}{2}$ to 1 inch long.

7. *Anthracnose, Bird's Eye Fruit Rot, Leaf Scab* — Widespread on grape. Small, sunken, light-colored spots with dark margins. Found on leaves, young shoots, tendrils, fruit, and canes. Canes may be girdled, causing dwarfing. Leaf spots may drop out leaving the leaves ragged and distorted. *Control:* Same as for Black Rot and Downy Mildew (both above) or apply thiram or ziram: (1) as the buds swell, (2) as buds break open, and (3) when new shoots are 7 to 9 inches long. Resistant grapes: Beacon, Concord, Delaware, Everglades, Fredonia, Herbemont, Lutie, Moore Early, Niagara, and President.
8. *Crown Gall* — Widespread. See under Apple, and (30) Crown Gall under General Diseases.
9. *Root Rots* — Plants decline in vigor, gradually die. Foliage is sparse and often yellowish. Fruit production declines sharply. Canes are winter-killed. Roots die back. Often associated with root-feeding nematodes. *Control:* See under Apple. Rootstocks vary in resistance.
10. *Wood Rots* — Plants gradually decline in vigor. Shoots may die back. Leaves may be yellowish or bronzed and scorched, pucker, and distorted. Often drop early. Fruit shrivel and dry up. Trunks and branches have soft, spongy, internal decay. Older vines are most severely infected. *Control:* Avoid wounding vines when cultivating or mowing. Follow the spray program as for Downy Mildew and Black Rot (both above). Prune and retie vines annually. Prune affected vines back to the ground.
11. *Root-knot* — Southern states. See (37) Root-knot under General Diseases. Root-knot resistant grape rootstocks are available. Check with your local nurseryman or extension plant pathologist. Nurserymen disinfect dormant, 1-year-old grape rootings by soaking in hot water (122° F. for 10 minutes; 125° F. for 5 minutes; or 127° F. for 3 minutes). Plant in clean or fumigated soil (pages 437-44), where feasible.
12. *Boron Deficiency* — Symptoms variable. Leaves develop enlarging, yellowish, then reddish, dead areas between the leaf veins or along the margins. Leaves often dwarfed, rolled, and distorted. Fall early. Growth may be stunted, bushy, and distorted. Fruit is tough and tasteless. *Control:* Have the soil tested and follow the recommendations. Apply borax in late winter and repeat once or twice more before bloom.
13. *Zinc Deficiency, Little Leaf* — See under Walnut. *Control:* Swab fresh pruning wounds of spur-pruned vines within 3 hours after pruning during the dormant period. Use 1 to 2 pounds of zinc sulfate (23 per cent metallic zinc) in a gallon of water. When the grape shoots are 12 to 15 inches long apply a thorough spray to the lower leaf surface and young flower clusters using 1 ounce of zinc sulfate and $\frac{1}{2}$ ounce of spray lime in a gallon of water.

14. *Dieback, Canker, Wilt, Cane or Shoot Blight* — Stems or canes are cankered. Foliage wilts and dies back. *Control:* Prune and burn all infected branches. Spray as for Downy Mildew (above).
15. *Pierce's Disease of Grape* — Primarily southern states. Symptoms very variable depending on the variety, age, and locality. Vines decline in vigor. Die in several months to 4 to 5 years. Most varieties are slow to leaf out in the spring. Shoots remain dwarfed; tend to die back from the tips. Affected leaves usually drop early, starting at the base of the shoots. In the fall, leaf margins and areas between the leaf veins show more and more scalding and browning. *Control:* If you are suspicious, check with your county agent, a local grower, or an extension plant pathologist. Plant only virus-free plants. Destroying infected vines and spraying to control leafhoppers which transmit the virus have not been satisfactory. Keep down weeds. Grape species in the Gulf states are resistant. Resistant or tolerant grapes: Champanel, Herbemont, Lake Emerald, and Lenoir.
16. *Fanleaf, Infectious Degeneration* (grape) — Leaves and new growth severely stunted. Secondary shoots develop abnormally with 2 or 3 buds forming double or treble nodes. Leaves come out at acute angle with the stem. Leaf margins more deeply cut than normal. Resemble a half-closed fan. Tissues are somewhat puckered and folded. Symptoms tend to disappear during the season. Fruit production is sharply decreased. Vine gradually becomes dwarfed. Symptoms somewhat similar to 2,4-D injury. Transmitted by the dagger nematode (*Xiphinema*) and possibly others, as well as by grafting. *Control:* Destroy infected vines when first found. Plant virus-free stock in fumigated soil (pages 440-44).
17. *Leafroll of Grape (White Emperor Disease)* — A virus disease, primarily in California, which is easily confused with potassium deficiency. Plants may be severely stunted. Leaves are darker than normal, turning a bronze or reddish color along the veins and yellow between the veins. Leaves turn color early with the lower leaves appearing scorched and rolled downward and inward. Fruit yield and quality are greatly reduced. Normally red fruit remains greenish-white, greenish-yellow, or pink. The virus interferes with the movement of potassium within the vine. *Control:* Destroy infected plants. Replant with virus-free stock. Keep the potassium level up, based on a soil test.
18. *Yellow Mosaic* (grape) — Symptoms variable. Leaves variously mottled and yellowed. Blossoms drop early. *Control:* Same as for Fanleaf (above).
19. *Other Leaf Spots or Blotches, Spot Anthracnose* — Widespread. Spots of various sizes, shapes, and colors on the leaves. *Control:* Same as for Black Rot (above).
20. *Other Root-feeding Nematodes* (citrus, dagger, pin, ring, root-lesion or meadow, spiral, sting, stylet or stunt, stubby-root) — Plants may be sickly, gradually decline. *Control:* Same as for Root-knot (above).
21. *Thread Blight* (peppervine, Virginia creeper) — Southeastern states. See under Walnut.
22. *Rust* (grape) — Southeastern states. See (8) Rust under General Diseases. *Control:* Same as for Black Rot and Downy Mildew (above).
23. *Chlorosis* — Mineral deficiency in alkaline soil. See under Maple.

GRAPEFRUIT — See Citrus

GRAPE - HYACINTH — See Tulip

GRAPE IVY — See Grape

GRASS PINK — See Carnation

GREAT LAUREL — See Rhododendron

GREEK VALERIAN — See **Phlox**

GREVILLEA — See **Silk-oak**

GROMWELL — See **Mertensia**

GROUNDCHERRY — See **Tomato**

GROUND-IVY — See **Salvia**

GROUND-MYRTLE — See **Vinca**

GROUND-PINK — See **Phlox**

GROUNDSEL — See **Chrysanthemum**

GUAVA — See **Myrtle**

GUERNSEY-LILY — See **Daffodil**

GUINEA BEAN — See **Cucumber**

GUINEA-HEN FLOWER — See **Tulip**

GYMNOCLADUS — See **Honeylocust**

GYPSOPHILA — See **Carnation**

HACKBERRY [CHINESE, COMMON, SOUTHERN or SUGARBERRY]
(*Celtis*)

1. *Witches'-broom* — Widespread, especially in central states. Unsightly, tight clusters of dwarfed twigs evident in the dormant season (Figure 124). Several hundred witches'-broom galls may be found on a single tree. Twigs may die back. Trees vary greatly in susceptibility. *Control:* Plant somewhat resistant types, e.g., Chinese and Southern. Cut and burn "brooms" back to healthy wood. A dormant lime-sulfur spray may be beneficial.
2. *Powdery Mildews* — Widespread. Powdery, white mold growth on both leaf surfaces. *Control:* If practical, apply a dormant spray of lime-sulfur. When mildew appears apply one or two sprays of Karathane or sulfur.
3. *Wood Rots* — Cosmopolitan. See under Birch, and (23) Wood Rot under General Diseases.
4. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases.
5. *Leaf Spots, Leaf Blight* — General. See under Maple.
6. *Winter Injury* — See under Elm.
7. *Downy Mildew* — See (6) Downy Mildew under General Diseases.
8. *Mosaic* — See under Elm.
9. *Mistletoe* — See (39) Mistletoe under General Diseases.
10. *Felt Fungus* — Southern states on neglected trees infested with scale insects. Dark, sometimes ringed, feltlike growth over scales. *Control:* Spray with DDT and malathion to control "crawler" stage of scales. Check with your extension entomologist regarding timing of sprays.
11. *Thread Blight* — Southeastern states. See under Walnut.

HALESIA — See **Silverbell**

HAMAMELIS — See **Witch-hazel**

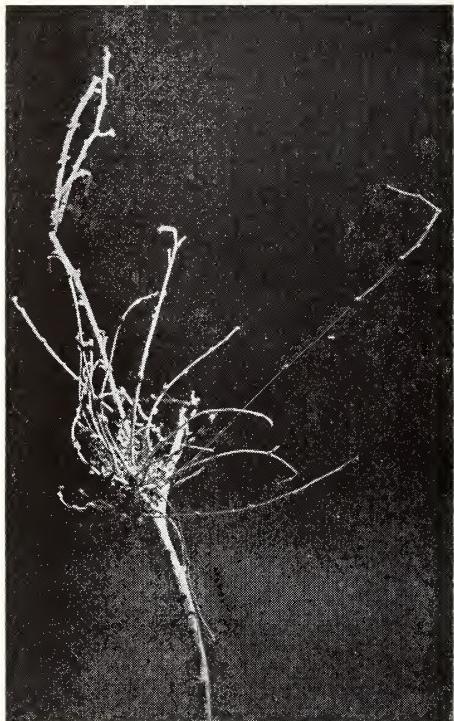


Fig. 124. Witches'-broom of hackberry.
(Iowa State University photo)

HARDHACK — See Spirea

HARDY AMARYLLIS — See Daffodil

HARDY ORANGE — See Citrus

HAREBELL — See Bellflower

HAWKSBEARD — See Chrysanthemum

HAWORTHIA — See Aloe

HAWTHORN — See Apple

HAZELNUT — See Birch

HEAL - ALL — See Salvia

HEARTS AND HONEY VINE — See Morning - glory

**HEATH [CORNISH, CROSS - LEAVED, DARLEY, FRINGED, MOOR, SCOTCH,
SPRING, TWISTED] (*Erica*); WINTERGREEN (EASTERN or WESTERN) or
CHECKERBERRY, TEABERRY, SHALLON or SALAL (*Gaultheria*); HEATHER
(*Calluna*); TRAILING - ARBUTUS [AMERICAN or MAYFLOWER, JAPANESE]
(*Epigaea*)**

1. *Wilt, Root and Collar Rot, Stem Rot* — Plants wilt, wither, and die from a rotting of the stem, crown, and roots. Leaves have a grayish appearance before wilting. *Control:* Plant disease-free plants in clean or sterilized soil (pages 437-44), which is light and well-drained. Avoid overwatering. Grow resistant varieties (e.g., *Erica persoluta*).
2. *Powdery Mildew, Twist* — May be serious on salal. Youngest leaves redden, later turn yellow to brown and drop early. Infected leaves are covered with whitish-gray mold patches especially on the lower leaf surface. Plants are dwarfed, bushy, and twisted. May die back. Blooming is reduced. *Control:* Dust or spray several times at weekly intervals using Karathane or sulfur. Space plants.
3. *Chlorosis, "Yellows"* — Plants lack vigor. New growth is stunted and pale yellow to whitish. Branches or entire plants die back. *Control:* Plant in light, well-drained soil which is quite acid. Spray plants monthly with iron sulfate. Avoid use of lime in any form.
4. *Rust (heath)* — Orange, powdery pustules on leaves. Infected leaves later turn yellow, wither, and drop early. *Control:* Spray or dust several times in early spring. Use zineb, maneb, or dichlone.
5. *Verticillium Wilt of Heath* — One or all branches may turn yellowish-green, wilt, and die. Disease usually progresses up the plant. *Control:* Grow disease-free, resistant varieties in soil free of the causal fungus. Or plant in sterilized soil.
6. *Damping-off, Cutting Rot* — Seedlings wilt and collapse. Cuttings rot at the base. *Control:* Use clean or sterilized soil for starting seed or cuttings. Avoid overwatering. Apply a drench of thiram or zineb (1 tablespoon per gallon) if disease strikes. Repeat 5 to 7 days later.
7. *Sooty Mold, Black Mildew* — Black patches of mold on foliage following insect attacks. *Control:* Apply malathion to control insects.
8. *Leaf Spots, Fruit Spot, Spot Anthracnose* — General on gaultheria. Spots of various colors, sizes, and shapes on leaves and fruit. If severe, leaves may wither and fall early. *Control:* Same as for Rust (above).
9. *Gray-mold Blight* — See (5) Botrytis Blight under General Diseases.
10. *Red Leaf Gall (gaultheria)* — Northern states. Small, red galls on the foliage. *Control:* Pick off and burn affected parts.

HEATHER — See Heath

HEAVENLY BAMBOO — See Nandina

HEBE — See Speedwell

HEDERA — See Ivy

HEDGENETTLE — See Salvia

HEDGEHORN — See Oleander

HELENIUM — See Chrysanthemum

HELIANTHEMUM — See Sunrose

HELIANTHUS — See Chrysanthemum and Lettuce

HELICHRYSUM, HELIOPSIS — See Chrysanthemum

HELIOTROPE (*Heliotropium*) — See Mertensia

HELLEBORUS — See Delphinium

HELXINE — See Babytears Vine

HEMEROCALLIS, DAYLILY (*Hemerocallis*)

1. *Leaf Spots* — Small, more or less round, tan to gray or black spots on the leaves. One leaf spot has a fairly broad, dark red border. *Control:* Collect and burn infected leaves as they appear. Cut and burn tops late in the fall.
2. *Root-knot* — Gall-like growths on the roots or discolored spots within the fleshy roots. *Control:* Plant disease-free stock in clean or fumigated soil (pages 437-44).
3. *Root Rots* — See under Geranium, and (34) Root Rot under General Diseases. May be associated with nematodes (e.g., root-knot, spiral).
4. *Gray-mold Blight* — See (5) Botrytis Blight under General Diseases.
5. *Russet Spot* — Greenish-yellow spots develop on the leaves. Spots later enlarge and turn an orange-brown color. Tips or even entire leaves may wither and die. Varieties differ greatly in susceptibility. *Control:* Grow plants in partial shade.
6. *Winter or Frost Injury* — Plants start slowly in the spring with a few yellowish, malformed leaves and little vigor. Most common with evergreen types. Crowns may decay. Shoots are often stunted or spindling. Plants may or may not recover. Frost injury due to late spring freezes appears as brown or tattered leaf tips followed later by normal development and flowering. *Control:* A mulch will help delay early growth until danger of frost is past.
7. *Daylily Blight* — One or more flower stems suddenly wither and die. Part or all of the foliage turns yellowish-brown and dies, usually after a flower stem has blighted. Roots are decayed. Plants usually recover in the same or the following season. *Control:* Unknown.

HEMLOCK — See Pine

HEN - AND - CHICKENS — See Sedum

HEPATICA — See Anemone

HERB ROBERT — See Cranesbill

HERCULES - CLUB — See Acanthopanax and Hopetree

HERONSBILL — See Cranesbill

HESPERIS — See Cabbage

HEUCHERA — See Hydrangea

HIBA ARBORVITAE — See Juniper

HIBISCUS — See Hollyhock

HICKORY — See Walnut

Highbush CRANBERRY — See Viburnum

HINOKI CYPRESS — See Juniper

HOLLY [AMERICAN or CHRISTMAS, CHINESE, ENGLISH or EUROPEAN (HEDGEHOG, SILVER - EDGE), JAPANESE, LUSTER LEAF, MOUNTAIN], DAHOON, INKBERRY, POSSUMHAW, WINTERBERRY (BLACK - ALDER) or NORTHERN HOLLY, JAPANESE WINTERBERRY, YAUPON (*Ilex*); MOUNTAIN HOLLY (*Nemopanthus*)

1. *Leaf Spots, Tar Spot, Leaf and Twig Blight, Spot Anthracnose* — Spots of various colors, sizes, and shapes on the leaves. Most spots are yellow, gray, to reddish-brown or black in color. Sometimes with a yellow or purplish margin. Spots may drop out leaving shot-holes. Young twigs may die back. May be serious in the nursery. *Control:* Pick off and burn spotted leaves where practical. Fertilize and water to maintain good tree vigor. Check with your nurseryman or extension horticulturist. If serious, spray with zineb, ferbam, or dichlone at 2-week intervals starting in late spring. Repeat sprays during late summer or early fall wet periods. Space plants. Plant where air circulation is fair to good. Removal of the lower branches plus collecting and burning the fallen leaves is often beneficial.
2. *Spine Spot* — Small, grayish-brown spots, usually surrounded with a purplish border, appear on the upper leaf surface in late winter or early spring. Spots are caused by wounding of spines from nearby leaves during high winds. *Control:* Plant trees in a sheltered location or erect canvas or burlap barriers to prevent wind-whipping of the leaves.
3. *Leaf Scorch* — Leaves, especially near the margins, are a scorched brown or purplish color in late winter or early spring. Occurs in wind-swept areas or when the sun shines brightly on ice-coated leaves. *Control:* Same as for Spine Spot (above).
4. *Powdery Mildews* — Mostly southern states. Grayish-white mold blotches on the foliage. *Control:* Where serious enough, spray with Karathane.
5. *Twig Blights, Cankers, Dieback* — Light brown to black, sunken cankers develop on the twigs and branches. Affected parts die back when girdled. *Control:* Prune out dead or cankered twigs and branches. Spray as for Leaf Spots (above) during cool, rainy, spring and fall weather.
6. *Sooty Molds, Black Mildews* — Primarily Gulf states. Black mold patches on foliage following attacks by insects. *Control:* Control whiteflies, scales, and other insects by using malathion sprays.
7. *Rust* — American holly is attacked in southern states. See (8) Rust under General Diseases.
8. *Wood Rots* — See under Birch, and (23) Wood Rot under General Diseases.
9. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases. May be associated with nematodes (e.g., burrowing, dagger, lance, pin, ring, root-knot, root-lesion, sheath, spiral, sting, stubby-root, stylet or stunt).
10. *Chlorosis* — Occurs in alkaline soils. See under Maple.
11. *Leaf Rot or Drop of Cuttings* (American and English holly) — Lower leaves decay and drop off when cuttings are in the rooting medium. *Control:* Stick cuttings in clean, fresh sand or sterilize old sand with heat or chemicals. Drench cutting bench with Terraclor 75 per cent (1 tablespoon per gallon). Use 1 pint per square foot. Take cuttings only from branches that do not touch the ground.
12. *Thread Blights* — Southeastern states. See under Walnut. *Control:* Spray as for Leaf Spots (above).
13. *Felt Fungus* — Southern states. Smooth, shiny, chocolate-brown to almost black growth on the bark. See under Hackberry.

HOLLYGRAPE — See Barberry

HOLLYHOCK [ANTWERP, COMMON] (*Althaea*); **ABUTILON, FLOWERING - MAPLE** (*Abutilon*); **ANODA**; **POPPY - MALLOW** (*Callirhoe*); **ROSELLE, ROSEMALLOW, FLOWER - OF - AN - HOUR, CHINESE HIBISCUS, COTTON - ROSE, CONFEDERATE - ROSE, ROSE - OF - SHARON or SHRUB - ALTHAEA, OKRA** (*Hibiscus*); **TREEMALLOW** (*Lavatera*); **MALLOW [HIGH, MUSK]** (*Malva*); **FALSE - MALLOW, BUSH - MALLOW, (Malvastrum)**; **SIDA; CHECKERMALLOW** (*Sidalcea*); **GLOBEMALLOW** (*Sphaeralcea*)

1. **Rusts** — General and destructive. Small, orange-yellow spots on the leaves, bracts, and stems. Pustules may later become powdery and reddish-brown to chocolate-brown in color. Mostly on underleaf surface. If severe, leaves may turn yellow, wither, and die early. See Figure 125. **Control:** Where practical, collect and burn all tops in the fall. Pick off and burn the first infected leaves as they appear in early

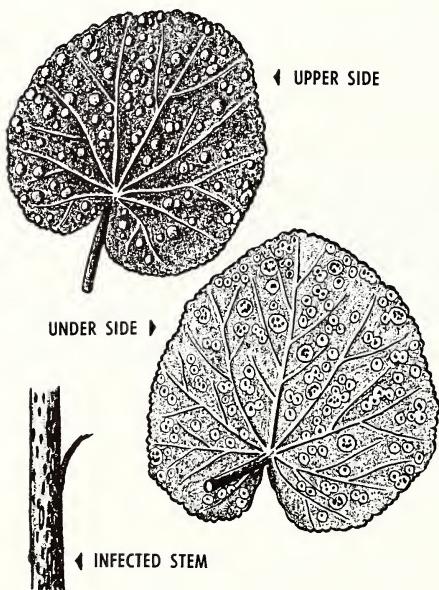


Fig. 125. Hollyhock rust.

spring. Destroy round leaf mallow or cheeseweed growing nearby. These plants may also be attacked, as are various wild grasses such as *Muhlenbergia*, *Sporobolus*, and *Stipa*. Keep down weeds. Plant only seed from healthy plants. Hollyhock varieties differ in resistance. Apply zineb, manebe, ferbam, dichlone, or sulfur at weekly intervals. Start as soon as growth begins. Repeat applications in late summer.

2. **Anthracnose, Dieback, Seedling Blight** — May be serious in hot, humid weather. Black blotches on the stem, petioles, and even the roots. Angular, grayish to black spots on the leaves with a dark margin, which may later drop out, leaving 'shot-holes.' Shoot tips may die back. **Control:** Same as for Rusts (above).
3. **Leaf Spots, Stem Canker, Pod Spot, Blossom Blight** — Spots of various colors, sizes, and shapes on the leaves. Some spots may drop out. If severe, leaves may wilt, roll, wither, and drop early. Similar spots may occur on the stems, pods, and flowers. May be covered with dense mold growth or sprinkled with black dots.

Control: Same as for Rusts (above). Plant in well-drained soil. Rotate. Keep plants growing vigorously.

4. *Stem Canker, Stem or Crown Rots, Southern Blight* — Girdling cankers on the stems near the ground line. Cankers often water-soaked and dark green at first. Later become covered with a cottony mold or become white, tan, or yellowish-brown in color. *Control:* Dig up and burn infected plants and 6 inches of surrounding soil. If practical, sterilize infected soil (pages 437-44) or treat with Terraclor (PCNB) dust or spray before planting. Rotate. Plant in well-drained soil. Avoid overwatering, shading, and crowding plants.
5. *Root-knot* — Primarily southern states. Hollyhock is very susceptible. See (37) Root-knot under General Diseases.
6. *Powdery Mildews* — Powdery white growth on leaves. *Control:* If serious enough, spray or dust at 7- to 10-day intervals using sulfur or Karathane.
7. *Crown Gall and Hairy Root* — See (30) Crown Gall under General Diseases.
8. *Bacterial Wilt* — Southern states. See under Tomato, and (15C) Bacterial Wilt under General Diseases.
9. *Verticillium Wilt* (abutilon, okra, poppy-mallow) — Widespread. See under Bell-flower, and (15B) Verticillium Wilt under General Diseases.
10. *Fusarium Wilt* (okra) — Serious in commercial okra-growing areas. Plants are progressively stunted and yellowed. Gradually die. Leaves wilt and roll. Dark streaks occur inside infected stems and roots. May be associated with nematodes (see below). *Control:* If destructive, plant in wilt-free soil or practice a 6-year rotation or longer.
11. *Mosaic, Infectious Variegation* (abutilon, Chinese hibiscus, lavatera, hollyhock, mallow, sida, sidalcea, treemallow) — Variegated forms of abutilon and treemallow are infected, often increasing the ornamental value. Leaves are mottled a bright yellow and green. Leaf veins may be yellow. Propagated by grafting and occasionally by seed of certain species. A branch or plant may apparently outgrow the virus and appear normal.
12. *Seed Rot, Damping-off* — Seeds rot. Stand is poor. Seedlings may wilt and collapse. *Control:* Plant in warm, well-drained soil. Treat seed with thiram, captan, chlor-anil, or dichlone. Avoid overwatering.
13. *Root Rots* — See (34) Root Rot under General Diseases. May be associated with nematodes (e.g., burrowing, dagger, lance, pin, reniform, ring, root-lesion or meadow, spiral, stem, sting, stubby-root, stylet or stunt).
14. *Curly-top* (mallow, okra) — See (19) Curly-top under General Diseases.
15. *Spotted Wilt and Yellows* (mallow, okra) — See (17) Spotted Wilt and (18) Yellows under General Diseases.
16. *Web Blight, Thread Blight* — Southeastern states. See under Bean and Walnut.
17. *Twig Blight* (hibiscus) — See under Maple.
18. *Strapleaf, Molybdenum Deficiency* (hibiscus) — Florida. See under Cabbage.

HOLLY - OSMANTHUS — See *Osmanthus*

HOLODISCUS, OCEANSPRAY, ROCKSPIREA (*Holodiscus*)

1. *Leaf Spots, Leaf Blight* — Western states. Spots of various sizes, shapes, and colors on the leaves. *Control:* If serious enough, apply several sprays at 10- to 14-day intervals during wet periods. Use zineb, maneb, or fixed copper.
2. *Powdery Mildew* — Western states. Grayish-white, mold patches on the foliage. *Control:* Apply 2 or 3 sprays of sulfur or Karathane, 10 days apart.

3. *Twig Canker, Dieback, Coral Spot* — Pacific Northwest. Twigs die back due to girdling cankers. Cankered areas may be covered with small, coral-pink fruiting bodies of the causal fungus. *Control:* Prune out and burn cankered twigs. Keep trees growing vigorously. Spraying as for Leaf Spots (above) may be beneficial.
4. *Witches'-broom* — Pacific Northwest. New lateral branches are very slender and wirelike with small, crowded leaves. In later years, several to many laterals arise from the same area on the stem (witches'-broom) and are much branched. Non-shaded leaves turn a bronzy-red color in early summer. Affected plants do not bloom. *Control:* Remove and burn infected plants. Protect healthy plants by controlling aphids, which transmit the virus.
5. *Fire Blight* — See under Apple.

HOMALOMENA — See Calla

HONESTY — See Cabbage

HONEYDEW MELON — See Cucumber

HONEYLOCUST (many horticultural varieties) (*Gleditsia*); ACACIA [CULTIVATED, MESCAT, PRAIRIE, SWEET], CATCLAW [LONG - FLOWERED, ROUND - FLOWERED, TEXAS] (*Acacia*); SILKTREE, "MIMOSA," LEBBEK (*Albizzia*); CAESALPINIA; PEA - TREE, PEA - SHRUB (*Caragana*); SENNA, GOLDEN - SHOWER (*Cassia*); REDBUD [CHINESE, COMMON, WESTERN, WHITE - FLOWERED], JUDAS - TREE (*Cercis*); YELLOWWOOD, AMERICAN YELLOWWOOD (*Cladrastis*); BLADDER - SENNA (*Colutea*); ERYTHRINA, RED - CARDINAL, CORAL - TREE, CORALBEAN (*Erythrina*); KENTUCKY COFFEETREE (*Gymnocladus*); LEADTREE (*Leucaena*); PARKINSONIA, JERUSALEM - THORN (*Parkinsonia*); POINCIANA; LOCUST [BLACK or FALSE - ACACIA, BRISTLY OR MOSSY, CLAMMY, KELSEY, NEW MEXICO] (*Robinia*); SOPHORA [MESCALBEAN or FRIJOLITO, VETCHLEAF], JAPANESE PAGODA - TREE or CHINESE SCHOLARTREE, SILKY SOPHORA (*Sophora*); WISTERIA [AMERICAN, CHINESE, JAPANESE] (*Wisteria*)

1. *Wood or Heart Rots* — General. See under Birch, and (23) Wood Rot under General Diseases. Wood rot fungi frequently follow borers and other insects.
2. *Twig Blights, Branch Cankers, Dieback, Wilt* — Discolored, slightly sunken cankers girdle the twigs and branches causing the parts beyond to wither and die. Small coral-pink to black "pimples" may be evident on affected wood. Trees may die back. Often follows freezing injury, borers, and bark wounds. *Control:* Severely cankered branches should be pruned out and burned. Keep trees growing vigorously by fertilizing and watering during summer dry periods. Grow varieties and species adapted and recommended for your area. Check with your nurseryman or extension horticulturist. Control borers with DDT or dieldrin sprays. Avoid bark injuries.
3. *Powdery Mildews* — Widespread. Powdery, grayish-white mold on the leaves and young shoots. If severe, leaves may turn yellow, wither, and fall. *Control:* Where feasible, apply sulfur or Karathane twice 10 days apart.
4. *Root and Crown Rots* — Trees decline in vigor. Foliage is thin and sickly. Leaves may turn yellow, wither, and drop early. See under Apple, and (34) Root Rot under General Diseases. May be associated with nematodes (e.g., burrowing, pin, root-knot, root-lesion, spiral, stubby-root, stylet or stunt).

5. *Fusarium Wilt of "Mimosa" or Silktree* — Serious in eastern and southeastern states. Leaves turn yellow, wilt, shrivel, and hang on the twigs. Leaves later fall and the branch dies. Brown streaks in the wood under the bark. Trunks may "bleed" extensively in the early stages of the disease. Tree dies within a year, branch by branch. Nematode injury to the roots speeds up wilting. *Control:* Cut down and burn infected trees. Disinfect pruning cuts with a disinfectant (e.g., 70 per cent denatured alcohol or 1:1,000 solution of mercuric chloride) and cover with a tree wound dressing (page 25). Grow wilt-resistant strains: Charlotte, Tyron, and U.S. No. 64. Better still, plant a different type of shade tree. Check with your extension horticulturist or nurseryman.
6. *Leaf Spots or Blights, Anthracnose, Tar Spot* — General in wet seasons. May be serious in southern states. Small to large, round to irregular spots and blotches on the leaves. Leaves may be blighted and drop early. *Control:* Same as for Maple Anthracnose and Leaf Spots.
7. *Collar Rot, Trunk Canker* — See under Dogwood.
8. *Witches'-broom, Brooming Disease* (black locust, honeylocust, sophora) — Eastern half of the United States. New leaves are stunted with light-colored veins. Dense clusters or bunches (witches'-brooms) of short, spindling shoots with dwarfed leaves. Brooming usually occurs in late summer. Brooms tend to die back during the winter. Common on young sprouts following cutting of twigs, branches, or trunk. Witches'-brooms also form on roots. *Control:* Where severe, remove and destroy infected trees. Trees have also appeared to recover naturally.
9. *Verticillium Wilt* — See under Maple. Greenish to brown or black streaks in the sapwood of larger wilting or dead branches.
10. *Sunscald, Winter Injury* — See under Apple.
11. *2,4-D Injury* — See under Grape and Figure 1.
12. *Crown Gall, Hairy Root* — See under Apple, and (30) Crown Gall under General Diseases.
13. *Root-knot* — See under Peach, and (37) Root-knot under General Diseases. Nurserymen soak dormant black locust trees in hot water (118° F.) for 30 minutes.
14. *Rusts* (acacia, bladder-senna, caesalpinia, honeylocust, leadtree, poinciana, sophora) — Reddish-brown or black, powdery pustules on the leaves. *Control:* Same as for Leaf Spots (above).
15. *Damping-off, Seedling Blights* — Seedlings wilt and collapse. Stem at ground line decays. *Control:* Set out seedlings in clean or sterilized soil (pages 437-44) which is light and well-drained. See under Pine.
16. *Chlorosis* — Iron or zinc deficiency in alkaline soils. See under Maple and Walnut.
17. *Mosaic* (wisteria) — New leaves first show yellowish blotches with scattered green "islands." Older leaves are laterally twisted. *Control:* Do not propagate from virus-infected plants.
18. *Mistletoe* — See (39) Mistletoe under General Diseases.
19. *Thread Blights* — Southeastern states. See under Walnut.
20. *Sooty Mold* (parkinsonia) — See (12) Sooty Mold under General Diseases.
21. *Felt Fungus* — Southern states. See under Hackberry.
22. *Downy Mildew* (redbud) — See (6) Downy Mildew under General Diseases.

HONEYSUCKLE — See Snowberry

HOPHORNBEAM — See Birch

HOPTREE or WAFER ASH (*Ptelea*); PRICKLY - ASH [COMMON, FLATSPINE, LIME], HERCULES - CLUB (*Zanthoxylum*)

1. *Leaf Spots, Tar Spot* — Not serious. Small, round to irregular spots on the leaves. *Control:* Pick off and burn spotted leaves. If serious enough, spray at 10-day intervals during rainy periods. Use zineb or maneb. Collect and burn fallen leaves in the autumn.
2. *Rusts* — Small, yellow or yellowish-orange spots on the leaves. Alternate host is a wild grass (*Tridens* or *Andropogon*). *Control:* Same as for Leaf Spots (above).
3. *Twig and Stem Canker* — Cankers girdle twigs causing them to die back. *Control:* Cut out cankered twigs. Spray as for Leaf Spots (above).
4. *Wood Rot* (prickly-ash) — See under Birch, and (23) Wood Rot under General Diseases.
5. *Mistletoe* (hercules-club, prickly-ash) — See (39) Mistletoe under General Diseases.
6. *Powdery Mildew* (hoptree, prickly-ash) — Widespread. Powdery, white mold on the leaves. *Control:* See under Horsechestnut.
7. *Sooty Blotch* — See under Apple, and (12) Sooty Mold under General Diseases.
8. *Root Rot* — See (34) Root Rot under General Diseases.

HOREHOUND — See *Salvia*

HORNBEAM — See *Birch*

HORSECHESTNUT [BAUMANN'S COMMON, DAMASK, RED, SCARLET], BUCKEYE [BOTTLEBRUSH, CALIFORNIA, OHIO, RED, TEXAS, YELLOW] (*Aesculus*)

1. *Leaf Blotch* — Widespread and serious, especially on common horsechestnut and Ohio buckeye. Small to large, irregular, reddish-brown spots or blotches often with

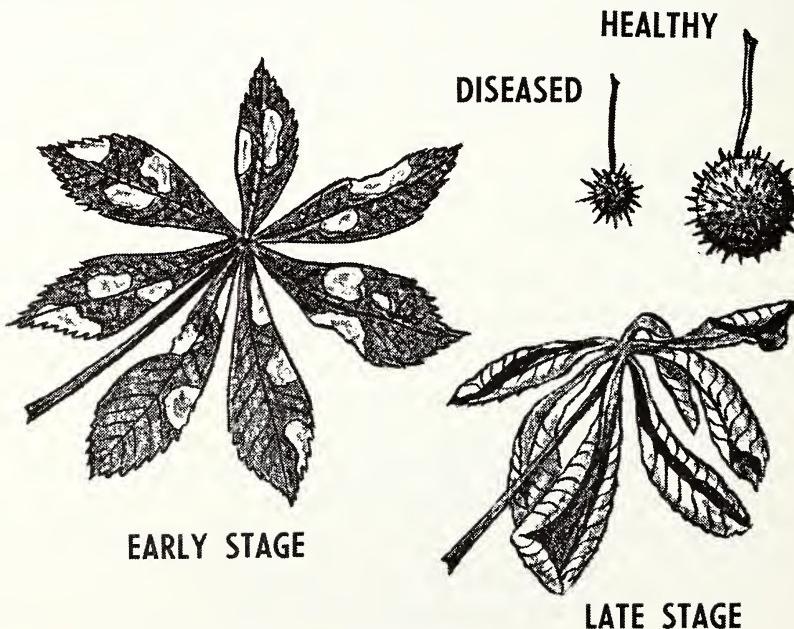


Fig. 126. Horsechestnut leaf blotch.

bright yellow borders on the leaves. Small black specks later appear in the centers of the spots. Infected leaves usually curl, dry, and fall prematurely. Trees often appear scorched by midsummer. Spots also occur on the nuts and leaf stalks. May closely resemble Leaf Scorch which results from drought and unfavorable growing conditions. See Figure 126. *Control:* Rake and burn leaves in the fall. If practical, spray two to four times, 10 to 14 days apart (or just before rainy periods) starting when the buds break open. Use Cyprex (dodine), zineb, ziram, captan, or fixed copper. Fertilize and water weakened trees.

2. *Leaf Scorch* — Margins of leaves become brown and curled in July or August. Scorch may spread over the entire leaflet. Most evident on the side of the tree exposed to wind and sun. Most prevalent in the top of the tree. *Control:* Prune susceptible trees to open them up. Water liberally during hot, dry periods. Fertilize to keep trees vigorous.
3. *Leaf Spots, Anthracnose* — Tips of shoots may die back several inches. Spots on leaves are round to irregular, vary in color and size. *Control:* Same as for Leaf Blotch (above).
4. *Powdery Mildews* — General, especially in eastern and central states. Underside of leaves covered with white mold patches in late summer and fall. *Control:* If practical, spray two or three times, 7 to 10 days apart, starting when mildew is first seen. Use sulfur or Karathane.
5. *Wood Rots* — See under Birch, and (23) Wood Rot under General Diseases.
6. *Twig Blight, Branch and Trunk Cankers, Dieback* — General. Twigs and branches die back. Leaves drop early. *Control:* See under Elm and Maple.
7. *Verticillium Wilt* — See under Maple. Leaves on individual branches wilt, turn yellow or brown, and drop from late spring to September. New, stunted leaves may form later in the season.
8. *Slime Flux, Wetwood* — See under Elm.
9. *Root Rot* — Cosmopolitan. See under Apple, and (34) Root Rot under General Diseases.
10. *Yellow Leaf Blister, Witches'-broom* — Yellow blisters on leaves which turn a dull red. Witches'-brooms are formed. See under Birch.
11. *Rust* — Midwest. See (8) Rust under General Diseases.
12. *Bleeding Canker* — Northeastern states. See under Beech and Maple.
13. *Mistletoe* — See (39) Mistletoe under General Diseases.

HORSEMINT — See *Salvia*

HORSERADISH — See *Cabbage*

HORTENSIA — See *Hydrangea*

HOSTA, PLANTAINLILY (*Hosta*)

1. *Crown Rot, Root Rot* — Plants wilt and collapse from a rot at the soil line or below. Crown may be covered with a gray or cottony mold growth. *Control:* Carefully dig out and burn infected plants and 6 inches of surrounding soil. Set out disease-free plants in clean or sterilized soil (pages 437-44). A week before planting work Terraclor (PCNB) dust into the top 4 to 6 inches of soil following the manufacturer's directions.
2. *Leaf Spots, Anthracnose* — Small to large spots on the leaves and stems. Leaves may be disfigured. *Control:* Collect and burn plant debris in the fall. Spray during wet periods using zineb, maneb, or fixed copper.

HOUNDSTONGUE — See Mertensia**HOUSELEEK — See Sedum****HOUSTONIA — See Buttonbush****HUCKLEBERRY — See Blueberry****HUSK - TOMATO — See Tomato****HYACINTH — See Tulip****HYACINTH - BEAN — See Pea**

HYDRANGEA [CHINESE, CLIMBING, HILLS - OF - SNOW, HOUSE or HORTENSIA, OAKLEAF, PANICLE, PEEGEE, SMOOTH, SNOWHILL] (*Hydrangea*); DECUMARIA; DEUTZIA [FUZZY, LEMOINE, SLENDER] (*Deutzia*); FENDLERA; CORALBELLS, ALUMROOT (*Heuchera*); MITREWORT or BISHOPSCAP (*Mitella*); MOCKORANGE [GOLDEN, GORDON, LEMOINE, STAR, SWEET, VIRGINAL, ZEYHER] (*Philadelphus*); SAXIFRAGE (*Saxifraga*); FOAMFLOWER (*Tiarella*)

1. *Powdery Mildews* (foamflower, heuchera, hydrangea, mitella, mockorange, saxifrage) — General. White to grayish, powdery mold patches on the leaves, stem tips, and flowers. Leaves and flowers are stunted and distorted. May die early. *Control*: Apply Karathane, Acti-dione, or sulfur two or three times, a week apart. Can combine with materials to control Leaf Spots or Gray-mold Blight (both below). Indoors, avoid extreme temperature changes and reduce the humidity. Varieties differ in resistance.
2. *Gray-mold Blight, Botrytis Blight, Bud Blight, Flower and Shoot Blight* — Cosmopolitan on hydrangea and mockorange, especially in humid areas. Flower clusters, buds, and shoots turn brown and rot. Often covered with a grayish-brown mold in damp weather. May follow frost injury. Serious in wet seasons. *Control*: Indoors, keep water off the foliage, space plants, and keep down the humidity. Carefully collect and burn infected flower clusters. Spray flower buds just before opening using captan, manebe, or zineb.
3. *Leaf Spots, Flower Spot* — General. May be serious in rainy seasons. Small- to medium-sized spots, round to angular or irregular, of various colors on the leaves and blossoms. Affected parts may sometimes be killed. *Control*: Same as for Gray-mold Blight (above). Where practical, pick off and burn spotted leaves. Apply captan, manebe, zineb, thiram, ferbam, or fixed copper at 7- to 10-day intervals, starting when the spots are first evident. Stop when flowers start to appear.
4. *Bacterial Wilt* (hydrangea) — Flowers, buds, and young leaves wilt and turn brown. Roots rot. Many plants may die. Most serious in hot, humid weather. *Control*: Destroy infected plant parts.
5. *Rusts* (coralbells, fendlera, foamflower, hydrangea, mitella, mockorange, saxifrage) — Widespread. Small, yellowish or reddish-brown, powdery pustules mostly on underside of leaves. Severely infected leaves may wither and die early. Alternate hosts: hemlocks or junipers. *Control*: Same as for Leaf Spots (above). Apply zineb, ferbam, manebe, or dichlone.
6. *Root-knot* — Deutzia is commonly attacked. See (37) Root-knot under General Diseases.
7. *Chlorosis* (primarily hydrangea) — Leaves yellowish, plants stunted, flower color is poor. Common in alkaline or lime-rich soils. *Control*: Have the soil tested. Grow plants in slightly acid soil. Add an acid fertilizer such as ammonium sulfate. Water

- plants with a weak solution of ferrous (iron) or magnesium sulfate or a mixture of the two. Or spray with an iron chelate following the manufacturer's directions.
8. *Wood Rot* — See under Birch, and (23) Wood Rot under General Diseases.
 9. *Sooty Mold or Blotch* (mockorange) — See (12) Sooty Mold under General Diseases.
 10. *Leaf and Stem Nematodes* (coralbells, hydrangea) — See (20) Leaf Nematode under General Diseases.
 11. *Dieback, Twig Canker* (hydrangea, mockorange) — Round to irregular, rough, discolored cankers on the stems. Twigs and branches are killed back. *Control:* Cut out and burn infected parts. Spray as for Leaf Spots (above).
 12. *Stem or Crown Rot* (hydrangea) — Primarily an indoor problem. Stem rots, wilts, and collapses from a rot at the soil line which may be covered with a cottony mold growth. See under Cutting Rot (below).
 13. *Cutting Rot, Damping-off* — Base of cuttings decay and fail to root. Seedlings wilt and collapse. *Control:* Plant in a sterile rooting medium. Avoid overwatering and plunging cuttings too deeply. Destroy infected cuttings.
 14. *Sunscald* (primarily hydrangea) — Exposed, tender leaves are "scorched" by hot sun, temperatures over 100° F., excessive wind, or toxic sprays. Leaf edges turn brown. *Control:* Keep plants out of direct sun and dry winds on hot days. Wrap trunks of young, recently transplanted trees. See under Apple and Elm. Varieties differ in resistance.
 15. *Leaf and Stem Smut* (coralbells) — See (11) Smut under General Diseases.
 16. *Root Rots* — See under Geranium, and (34) Root Rot under General Diseases. May be associated with root-feeding nematodes (e.g., dagger, pin, ring, spiral, stem, root-lesion or meadow).
 17. *Ringspots* (hydrangea) — Symptoms variable. Leaves dull and yellowish with dark green to yellowish blotches, yellow or brown rings and oakleaf patterns. Plants dwarfed with stunted leaves. Leaves often irregular in shape, narrow, sometimes stiff and brittle. Flowers stunted, may open irregularly, with green and colored flowers in the same cluster. *Control:* Destroy infected plants. Take cuttings *only* from healthy plants.

HYMENOCALLIS — See Daffodil**HYPERICUM — See St. - Johns - wort****HYSSOP (*Hyssopus*) — See Salvia****IBERIS — See Cabbage****ICEPLANT, FIGMARIGOLD (*Mesembryanthemum, Cryophytum*)**

1. *Root-knot* — See (37) Root-knot under General Diseases.
2. *Sooty Mold* — Black moldy patches on the foliage. *Control:* Apply malathion to control scales, mealybugs, and other insects.

ILEX — See Holly**ILLICIUM — See Magnolia****IMPATIENS — See Balsam****INCENSE - CEDAR — See Juniper****INDIAN CHERRY — See Buckthorn**

INDIAN - CUP — See Chrysanthemum

INDIAN CURRANT — See Snowberry

INDIAN PAINTBRUSH — See Snapdragon

INDIAN SHOT — See Canna

INDIAN - TOBACCO — See Lobelia

INDIA RUBBER PLANT or TREE — See Fig

INDIGO (*Indigofera*), INDIGOBUSH — See False - indigo

INKBERRY — See Holly

INULA — See Chrysanthemum

IPOMOEA — See Morning - glory and Sweetpotato

IRESINE — See Cockscomb

IRIS [CRESTED, DANISH, DUTCH, DWARF, ENGLISH, JAPANESE or KAEMPFERI, SPANISH, SIBERIAN, TALL BEARDED or GERMAN, and ZUA] (*Iris*); BABIANA; BLACKBERRY - LILY (*Belamcanda*); BLUE - EYED GRASS (*Sisyrinchium*); WANDFLOWER (*Sparaxis*); STREPTANTHERA; WATSONIA

1. *Crown, Rhizome, Bulb or Corm Rots, Root Rots* — General and serious, especially on iris. Young fans may fail to grow in the spring. Leaves turn yellow, wither, and die. Leaves suddenly wilt and collapse or die back gradually from the tips. Rhizome or bulb, crown, and leaf bases may be dark green, slimy and foul-smelling (*Bacterial Soft Rot*), or covered with a cottony, gray or bluish mold growth, shriveled, dried, and rotted (fungus rots). Roots may decay; be few or none. The newer iris hybrids appear more susceptible than the older varieties. See Figure 37C and Figure 43B under General Diseases, as well as Figure 127. *Control:* Plant firm, disease-free stock, shallow in clean or sterilized soil (pages 437-44). Before planting, soak rhizomes or bulbs for 10 minutes in a 1:1,000 solution of mercuric chloride (see page 427 for precautions), Semesan solution (1 heaping tablespoonful per gallon), or in a phenyl mercury solution for 30 minutes. Follow the manufacturer's directions. Space plants and plant in well-drained soil in a sunny location where these plants have not grown for at least several years. Dig and divide clumps every 2 to 4 years. Dry rhizomes or bulbs thoroughly in the sun for several days after digging. Avoid bruising when digging and cleaning. Avoid wounding leaves or flower stalks and overwatering. Keep down weeds. If rot strikes, dig up and burn plants that are seriously infected. Cut out the rotted areas of slightly infected rhizomes. Drench the soil around infected plants using the same strength mercuric chloride (1 pint per square foot) or use Semesan (1 ounce in 3 gallons of water). Phenyl mercury may also be applied following the manufacturer's directions. Repeat the drench treatment 10 days later. Control insects, especially iris borers, using DDT. Combine with Leaf Spot sprays (see below). Certain fungus rots are controlled by mixing Terraclor (PCNB) dust into the top 4 to 6 inches of soil about a week before planting. Follow the manufacturer's directions.
2. *Leaf Spots, Blotch* — General and serious. Small, grayish-brown to brown spots with water-soaked, yellowish, or dark brown margins on the leaves. Spots often enlarge and run together causing the leaves to turn yellow and die prematurely from the tip down. Spots may also occur on the stems and flower buds. Plants are gradually

weakened. See Figure 15A under General Diseases. *Control:* Same cultural practices as for Crown Rots (above). Cut off and burn heavily spotted leaves as they occur. Spray four to six times, 7 to 10 days apart, starting just before bloom. Use zineb, maneb, phaltan, captan, or phenyl mercury to which detergent or spreader-sticker is added (page 104). Varieties differ greatly in susceptibility, especially iris.

3. *Mosaic, Stripe* — General on dwarf iris and certain tall, bearded types. Also attacks other plants listed. Symptoms variable. Even masked in some varieties. Leaves and

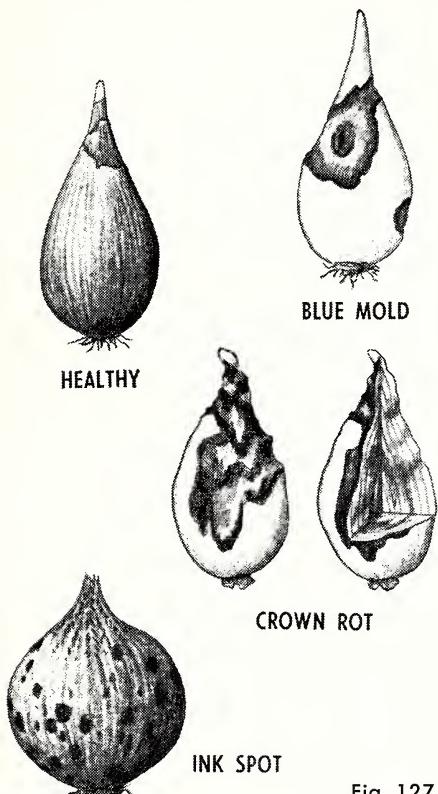


Fig. 127. Iris bulb rots.



Fig. 128. Iris mosaic.

bud sheaths are mottled light and dark green, or show light, yellowish-green streaks. Flowers may be mottled and streaked or fail to open. Plants and flowers may be stunted. See Figure 128. *Control:* Dig and burn infected plants when first found. Plant disease-free stock. Control aphids, which transmit the virus, using malathion or nicotine sulfate.

4. *Scorch, Red Fire* (tall and dwarf bearded iris) — Central leaves turn a bright, reddish-brown at the tips in early spring. Later the whole fan of leaves is "scorched" and withered. Roots are soft, dead, reddish, hollow, and later disintegrate. Rhizome becomes reddish colored. Plants often die. Nematodes are often found in the roots of affected plants. *Control:* Dig up and burn infected plants. Same as for Crown Rots (above). Plant clean stock in soil fumigated with D-D, EDB, or chloropicrin. See pages 440-44 in the Appendix.

5. *Bacterial Leaf Spot or Blight* (*iris*, *belamcanda*) — Irregular, dark green, water-soaked spots and streaks on the leaves and flower stem. Infected areas enlarge, may run together and turn a yellowish-green and finally brown. Leaves and flower stem may collapse. See Figure 129A. *Control:* Same as for Leaf Spots (above), except that spraying is ineffective. Avoid damp, shaded locations and crowding plants together.
6. *Rusts* — More common on wild iris and cultivated varieties of *Iris germanica* type. Small, reddish-brown, dark brown or black, powdery pustules on the leaves and stems. Often surrounded with a yellowish border. Leaves of certain susceptible varieties may wither and die early. See Figure 129B. *Control:* Collect and burn the tops in the fall. Most *iris* varieties are highly resistant or immune. Keep down weeds. If severe enough, spray as for Leaf Spots (above) or use dichlone or ferbam.
7. *Blossom Blight* (*iris*) — Blossoms spotted or blighted in wet weather. *Control:* Spray as for Leaf Spots (above). Use zineb or captan. Pick off and destroy spotted flowers when first found.
8. *Bulb and Stem Nematode* — Yellow spots or streaks on the stem and sheath. The base of the stem under the outer coating may turn gray, brown or lead-colored and streaked. Discolored areas appear as rings when bulbs are cut through. Infested



Fig. 129. A. Bacterial leaf spot of iris. B. Iris rust.

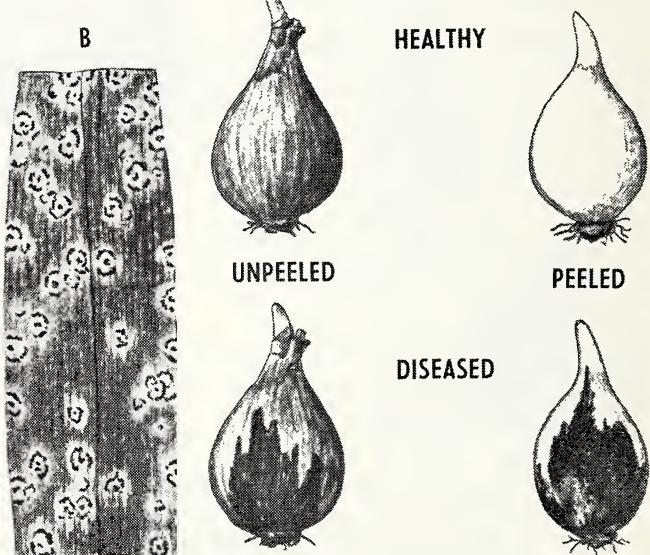


Fig. 129. A. Bacterial leaf spot of iris. B. Iris rust.

plants may be stunted and dry up prematurely. Roots discolored, decayed, or lacking. Bulbs decay. See Figure 130. *Control:* Plant nematode-free stock in clean soil. If suspicious, treat dormant *iris* bulbs by soaking in hot formalin solution 1:200 (1 teaspoonful of 37-40 per cent commercial formaldehyde in 1 quart of water) at 110° F. for 3 hours. Dry and plant as soon as possible.

9. *Meadow or Root-lesion, Lance, Root Plate, Pin, Spiral Nematodes* — Plants dwarfed. May die from a rotting of the roots. Root system is often matted and "tufted."



Younger, newer roots have small, reddish-brown spots on them. Rot organisms and blue mold often later destroy the infested bulb. *Control:* Plant nematode-free stock in soil pasteurized by heat or chemicals. Destroy badly infested plants.

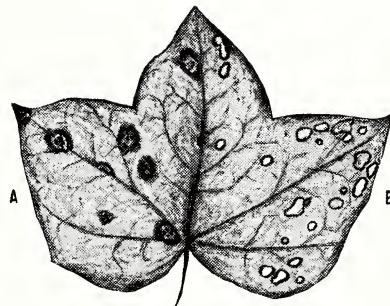
10. *Root-knot* — Knobby, beadlike galls or knots form on the roots. Plants may be dwarfed and sickly. Leaves die gradually, from the tips down. *Control:* Same as for Meadow Nematode (above).
11. *Ink Disease, Leaf Blight* (bulbous iris) — Irregular, ink-black stains, often ring-like, on outer skin of bulb scales. The blotches enlarge to cover the whole scale. Bulbs may turn black, shrivel, and become hard. Black, sooty blotches on the leaves which later turn reddish-brown. Leaves wither from the tip down. See Figure 127. *Control:* Destroy infected plants and infected leaves. Treat lightly infected bulbs as for Bulb Nematode (above). Spray as for Leaf Spots (above). Dig bulbs each year and replant in a new location.
12. *Blindness, Blasting* (forced iris) — Flowers do not develop or flower buds do not open after forming. May be caused by rotting of underground parts, late digging, low curing or precooling temperature, small bulb size, and other factors.
13. *Chlorosis* — Mineral deficiency in alkaline soil. See under Rose.

IRONWOOD — See Birch

IVY [BALTIC, CANARY, ENGLISH] (Hedera). IVY — See Grape for Boston, Engelmann, Grape, and Marine-ivy. See Snapdragon for Kenilworth ivy.

1. *Fungus Leaf Spots, Stem Spots, Twig Blight, Spot Anthracnose or Scab, Anthracnose* — Small to large, round to irregular spots of various colors on the leaves and stems. Often with conspicuous margins. Stems may be blighted, wither and die

Fig. 131. Leaf spots of English ivy. A. Bacterial leaf spot, B. Phyllosticta leaf spot.



back. Infected leaves may wither and fall early. See Figure 131. Plants may appear ragged. *Control:* Where practical, pick off and burn infected plant parts. If severe, spray weekly using zineb, maneb, or fixed copper. Do not plant where high temperatures and moist conditions are prevalent.

2. *Winter Injury, Sunscald* — Foliage is scorched and browned in early spring. *Control:* Follow the best local cultural practices. Check with your extension horticulturist or landscape architect. Plant only where adapted.
3. *Bacterial Leaf Spot, Stem Canker* — Common indoor problem, where moist. Small, round, light green, water-soaked spots on the leaves. Spots later enlarge, turn brownish-black, and develop reddish-purple borders. Black areas on the petioles or stems may cause girdling and withering of the portions beyond. Plants may be dwarfed, with sickly yellowish-green foliage. *Control:* Same as for Fungus Leaf

Spots (above). Apply fixed copper, bordeaux, or streptomycin. Indoors, keep water off the foliage. Avoid high humidity.

4. *Powdery Mildew* — See (7) Powdery Mildew under General Diseases.
5. *Sooty Mold* — Common on ground cover under trees. The black mold grows on insect honeydew dropped from aphids feeding in the trees above. See (12) Sooty Mold under General Diseases.
6. *Root Rots* — See (34) Root Rot under General Diseases. Often associated with root-feeding nematodes (e.g., lance, spiral, stem, stubby-root, stylet or stunt).

IVY - ARUM — See Calla

IXIA — See Gladiolus

IXORA — See Buttonbush

JACARANDA — See Catalpa

JACKBEAN — See Bean

JACK - IN - THE - PULPIT — See Calla

JACOBS - LADDER — See Phlox

JACQUEMONTIA — See Morning - glory

JADE PLANT — See Sedum

JAPANESE LAWNGRASS — See Lawnglass

JAPANESE PAGODATREE — See Honeylocust

JAPANESE PLUM - YEW (*Cephalotaxus*)

1. *Twig Blight* — See under Juniper.

JAPANESE SPURGE — See Pachysandra

JASMINE [COMMON, ITALIAN, PRIMROSE, ROSY, WINTER] (*Jasminum*)

1. *Leaf Spots, Spot Anthracnose or Scab* — Leaves spotted. May fall early. *Control:* Pick off and burn infected leaves. If serious enough, spray several times, 10 to 14 days apart. Use zineb or maneb.
2. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases. May be associated with root-feeding nematodes (e.g., burrowing).
3. *Blossom Blight* — See (31) Blossom Blight under General Diseases.
4. *Crown Gall* — See (30) Crown Gall under General Diseases.
5. *Root-knot* — See under Peach, and (37) Root-knot under General Diseases.
6. *Crown Rot, Southern Blight* — See (21) Crown Rot under General Diseases.
7. *Rust* — Uncommon. Leaves, stem, flowers, and fruit are deformed with raised, powdery pustules which later turn brown. *Control:* Same as for Leaf Spots (above).
8. *Variegation, Infectious Chlorosis* — See under Hollyhock.
9. *Stem Gall* — Small galls occur on stems. *Control:* Cut out and burn affected parts. Spray as for Leaf Spots (above).

JERUSALEM - ARTICHOKE — See Lettuce

JERUSALEM - CHERRY — See Tomato

JERUSALEM - CROSS — See Carnation

JERUSALEM - THORN — See Honeylocust

JESSAMINE — See Butterflybush

JETBEAD, WHITE KERRIA (*Rhodotypos*)

1. *Leaf Spot, Anthracnose* — Leaves spotted in rainy seasons. *Control:* Pick off and burn infected leaves. If serious enough, spray several times, 10 to 14 days apart, using zineb, ferbam, or captan.
2. *Twig Blight, Coral Spot* — Twigs die back. Cankers on affected parts may be covered with bright, coral-colored pustules. *Control:* Cut out and burn blighted twigs. Fertilize and water to maintain good vigor.
3. *Fire Blight* — See under Apple.

JOE - PYE - WEED — See Chrysanthemum

JOSEPHSCOAT — See Cockscomb

JOSHUA - TREE — See Yucca

JUDAS - TREE — See Honeylocust

JUGLANS — See Walnut

JUNEBERRY — See Apple

JUNGLEFLAME — See Buttonbush

JUNIPER [ALLIGATOR, ANDORRA, CHINESE (COLUMNAR, GLOBE, HETZ BLUE, PYRAMIDAL), COMMON (DWARF SWEDISH, SWEDISH), CREEPING, GREEK, HILL, IRISH, JAPANESE, JAPANESE SHORE, MOUNTAIN, MEYER'S, NEEDLE, PFTZER, PROSTRATE, ROCKY MOUNTAIN, SAVIN, WAUKEGAN], CREEPING CEDAR, REDCEDAR [CANAERT, CREEPING, EASTERN, FOUNTAIN, GLOBE, GOLDTIP, HILL'S PYRAMIDAL, KETELEER, KOSTER, SCHOTT, SILVER, SOUTHERN, WEEPING, WESTERN] (*Juniperus*); WHITE-CEDAR [ATLANTIC, SOUTHERN], LAWSON or PORT ORFORD CEDAR; YELLOW - CEDAR [ALASKA or NOOTKA], HINOKI CYPRESS, SAWARA - CYPRESS (*Chamaecyparis* or *Retinospora*); CRYPTOMERIA: CYPRESS [ARIZONA, COLUMNAR ITALIAN, ITALIAN, MONTEREY] (*Cupressus*); INCENSE CEDAR (*Libocedrus*); ARBORVITAE [AMERICAN (numerous horticultural forms), EASTERN or NORTHERN WHITE-CEDAR (numerous horticultural forms), BLACK AMERICAN, GIANT, DARK GREEN GIANT, COLUMNAR GIANT, GLOBE, GOLDEN, GOLDEN BIOTA, JAPANESE, KOREAN, ORIENTAL, PYRAMIDAL, SILVER] (*Thuja*); HIBA ARBORVITAE, DWARF HIBA ARBORVITAE (*Thujopsis*)

1. *Rusts, Gall Witches'-broom* (primarily chamaecyparis, incense-cedar, juniper, red-cedar) — General. Upright junipers (redcedars) are susceptible while prostrate or horizontal types are generally resistant. Greenish-brown to reddish-brown, bean-shaped galls (up to 2 inches in diameter) or witches'-brooms on small branches. The tips of the branches may die back. Elongated, rough, dark-colored, swollen cankers (or burls) may develop on the larger branches and trunk. Masses of orange to brown-colored, jellylike tendrils are produced in wet spring weather. Chamaecyparis seedlings may be severely stunted. See Figure 22D under General

Diseases. A large number of alternate hosts, some of which are listed under Apple. Other hosts include bayberry, sweetfern, and waxmyrtle. *Control:* Destroy worthless, upright junipers or alternate hosts. If practical, hand pick galls or prune out witches'-brooms by late winter or spray monthly, May to September, using Actidione or a mixture of ferbam and sulfur. Spray with Actidione, Elgetol, or Krenite when tendrils are 1/16 of an inch out. Follow the manufacturer's directions.

2. *Twig Blights, Needle Blight, Dieback* — Widespread. Needles, twigs, and smaller branches turn light brown to reddish-brown and gradually die back from the tips. Both old and new leaves and twigs may be involved. Serious on seedlings and young trees in wet seasons. Entire branches or even trees may be killed. Tiny black dots usually appear later on infected parts. Often confused with normal fall browning of the inner leaves, winter injury, and damage from spider mites. *Control:* Prune out and burn blighted parts. Destroy infected plants in the nursery. Avoid wounding when transplanting or cultivating. Apply phenyl mercury, fixed copper, captan, maneb, or Actidione, plus spreader-sticker (page 104) at about 1- to 2-week intervals during spring and fall wet seasons. Follow the manufacturer's directions. Space plants to provide good air circulation. Avoid overhead sprinkling in the nursery. Somewhat resistant *junipers*: Spiny Greek, Hill, and Keteleer redcedar.
3. *Leaf Blights, Seedling Blight, Nursery Blights, Needle Cast* (primarily American and giant arborvitae) — Widespread and damaging. Small, round to irregular, olive-brown to black cushions form on the leaves in late spring. The infected leaves appear scorched. Later the leaves drop. Branches are left bare. Most common on the bottom ½ of young trees. *Control:* Same as for Twig Blights (above). Resistant arborvitae varieties may be available soon.
4. *Winter Injury* — General. Last year's foliage is scorched, turns brown and dies back from the tips and margins. Injury is evident in late winter and spring. Heavy coatings of ice and snow may seriously injure or kill if allowed to remain on trees and shrubs. *Control:* Water shrubs deeply in the fall, and during dry periods. Mulch plants for winter to conserve moisture, prevent deep freezing plus alternate thawing and freezing of the soil. Plant in a location protected from drying winter winds and sun or erect protective screens made of burlap, canvas, or other material. Control mites with malathion or other sprays. Grow chamaecyparis only where adapted.
5. *Twig and Branch Cankers* — Serious on Monterey and Italian cypress in California. Discolored, slightly sunken cankers on the twigs and branches which gradually girdle and kill the portions beyond. Branches or entire trees drop their yellowed and browned leaves and finally die. *Control:* Prune off affected parts well below the cankers. Spray as for Twig Blights (above).
6. *Natural Leaf-browning and Shedding* — Noticeable on arborvitae and certain junipers. Older and inner leaves turn brown and fall in large numbers in early to late fall. May occur quite suddenly in a week or two. *Control:* This is a normal plant reaction.
7. *Chlorosis* — Occurs in alkaline soils. See under Maple.
8. *Sooty Mold, Black Mildews* — See (12) Sooty Mold under General Diseases.
9. *Wood and Heart Rots* — Cosmopolitan. See under Birch, and (23) Wood Rot under General Diseases.
10. *Crown Gall* — See under Apple, and (30) Crown Gall under General Diseases.
11. *Root Rots* — Foliage often wilts and changes color. Branches or top dies back. Trees of all ages gradually decline and die from rot in the trunk base and larger roots. Very serious on Port Orford cedar or Lawson cypress and Hinoki cypress along the Pacific Coast. *Control:* See under Apple. Nurserymen grow disease-free

stock in new or sterilized soil. Avoid large plantings of Port Orford cedar or Hinoki cypress as windbreaks or hedges. Remove and destroy affected plants, including the roots.

12. *Mistletoes* — Widespread. See (39) Mistletoe under General Diseases. Serious on incense-cedar, causing spindle-shaped swellings in the branches.
13. *Brown Felt Blight, Snow Blight* (*juniper, arborvitae*) — See under Pine.
14. *Root-feeding Nematodes* (dagger, lance, pin, spiral, stubby-root, stylet or stunt, ring, root-lesion) — Associated with stunted, sickly trees in a state of decline. See under Peach.

JUPITERS - BEARD — See Valerian

KALANCHOË — See Sedum

KALE — See Cabbage

KALMIA, KALMIOPSIS — See Blueberry

KALOPanax — See Acanthopanax

KANGAROO VINE — See Grape

KENILWORTH IVY — See Snapdragon

KENTUCKY COFFEETREE — See Honeylocust

KERRIA

1. *Leaf and Twig Blight, Leaf Spots, Canker* — Widespread. Small, round to irregular, light to reddish-brown spots with a darker margin on the leaves. If spots are numerous, leaves turn yellow and die prematurely. Spots (cankers) on the stems are round and reddish-brown to black in color. The spots may run together forming large cankers. The bark may split and twigs die back. The dwarf, variegated Kerria is very susceptible. *Control:* Prune off and burn affected parts. Collect and burn fallen leaves. Spray or dust several times, 10 days apart, starting when the leaves are $\frac{1}{4}$ inch long. Use zineb, ferbam, manebe, or fixed copper.
2. *Twig Blights, Canker* — Widespread. Oval to elongated or irregular, tan-colored spots on the stems. The centers of the spots may be sprinkled with tiny black dots or bright, coral-red pustules. Twigs may die back. Leaves may become blighted. *Control:* Same as for Leaf and Twig Blight (above).
3. *Root Rot* — See (34) Root Rot under General Diseases.
4. *Fire Blight* — See under Apple.

KNIPHOFIA — See Redhot - pokerplant

KOCHIA — See Beet

KOELREUTERIA — See Goldenrain - tree

KOHLRABI — See Cabbage

KOLKWITZIA — See Viburnum

KUMQUAT — See Citrus

LABRADOR - TEA (*Ledum*); LEUCOTHOË [COAST, DROOPING, SWEETBELLIS] (*Leucothoe*); BOX SANDMYRTLE (*Leiophyllum*)

1. *Leaf Galls* — Gall-like growths and red spots on the leaves. *Control:* Prune and burn infected parts when first seen. Plant disease-free stock. If necessary, apply a

dormant spray before buds swell. Repeat applications during wet periods. Use ferbam, zineb, or maneb.

2. *Spot Anthracnose* (Labrador-tea, leucothoë) — Not serious. Grayish-white spots on the leaves with reddish-brown borders and zoned with a purplish ring. Infected areas also appear on the capsules, petioles, and branches. *Control:* Pick off and burn infected parts. Spraying with zineb or maneb should give good protection.
3. *Rusts* (Labrador-tea) — Causes little injury. Powdery pustules on the leaves. Alternate hosts are spruces. *Control:* Not necessary. Spraying as for Spot Anthracnose and Leaf Galls (both above) should be beneficial.
4. *Leaf Spots, Tar Spot, Black Spot* — Spots of various sizes, shapes, and colors on the leaves. The centers of the spots may later be sprinkled with black dots. See

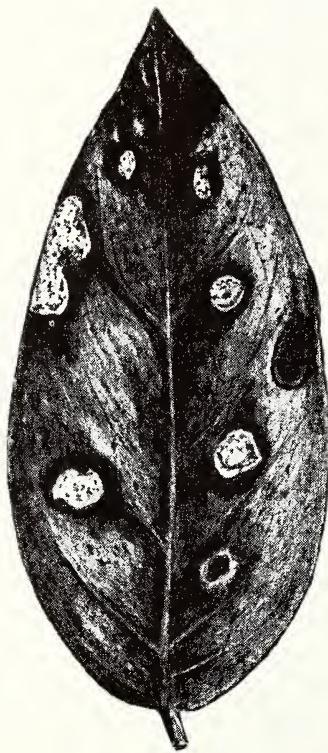


Fig. 132. Leucothoe leaf spots.

Figure 132. *Control:* Pick off and burn infected leaves. Where serious, apply ferbam or zineb at 10- to 14-day intervals, starting when the new leaves are $\frac{1}{4}$ inch out.

5. *Black Mildew* (leucothoë) — Gulf states. See (12) Sooty Mold under General Diseases.
6. *Felt Fungus* (leucothoë) — Southern states. See under Hackberry.
7. *Powdery Mildew* (Labrador-tea) — See (7) Powdery Mildew under General Diseases.

LABURNUM — See **Goldenchain**

LACHENALIA — See **Tulip**

LADYS - SORREL — See **Oxalis**

LAELIA — See **Orchids**

LAGENARIA — See **Cucumber**

LAGERSTROEMIA — See **Crapemyrtle**

LAMBKILL — See **Blueberry**

LAMBS - EARS — See **Salvia**

LAMBSLETTUCE — See **Valerian**

LANTANA [TRAILING, WEEPING] (*Lantana*); **LEMON - VERBENA**,
FOGFRUIT, WHITEBRUSH (*Lippia*); **BEAUTYBERRY, FRENCH - MULBERRY**,
JEWELBERRY [JAPANESE, KOREAN, GIRALD'S or BODINIER
BEAUTYBERRY] (*Callicarpa*); **BLUEBEARD, BLUE MIST SPIREA** (*Caryopteris*);
GLORYBOWER (*Clerodendron*); **PHYLA**; **GARDEN VERBENA, VERVAIN**
(*Verbena*); **CHASTE - TREE** (*Vitex*)

1. *Root-knot* — Widespread. See (37) Root-knot under General Diseases.
2. *Leaf Spots, Anthracnose, Spot Anthracnose* — Small to large spots of various colors and shapes on the leaves. *Control:* Pick off and burn spotted leaves. Spray at 7- to 10-day intervals during wet periods. Use zineb, maneb, or captan.
3. *Leaf Nematode* (*lantana, verbena*) — Brown blotches on the leaves. First bounded by the veins. Later the leaves are killed, starting at the base of the stem. *Control:* See under Chrysanthemum, and (20) Leaf Nematode under General Diseases.
4. *Stem Rot, Blight* — See under Geranium.
5. *Black Mold or Mildew* — See (12) Sooty Mold under General Diseases.
6. *Fusarium Wilt* (*lantana*) — See (15A) Fusarium Wilt under General Diseases.
7. *Powdery Mildew* (*verbena*) — General. Powdery, white mold growth on the leaves and stems. *Control:* Space plants. Apply two sprays of Karathane, 10 days apart.
8. *Rusts* (*lantana, verbena*) — Small, yellow to dark brown pustules on the leaves. Alternate host may be wild grasses. *Control:* Where practical, same as for Leaf Spots (above).
9. *Bacterial Wilt* (*verbena*) — Leaves turn yellow, wilt, and die. Plants often die before blooming. Inside of stems is dark brown near the soil line. *Control:* Set disease-free plants in clean or sterilized soil (pages 437-44).
10. *Flower Blight* (*verbena*) — Flower petals spotted, may rot. Affected areas are covered with a dense gray mold in damp weather. *Control:* Carefully pick off and burn spotted flowers. Spray as for Leaf Spots (above).
11. *Spotted Wilt* (*verbena*) — See (17) Spotted Wilt under General Diseases.
12. *Downy Mildew* (*verbena*) — See (6) Downy Mildew under General Diseases.
13. *Gray Patch* (*phylla*) — California in hot weather. Ground cover plants dry out and die in patches a foot or more in diameter. *Control:* Try working Terraclor dust into the soil in affected areas or spot drench with Terraclor 75. Follow the manufacturer's directions.
14. *Mosaic* (*lantana, verbena*) — Light green and yellow mottling on the leaves. Leaves may be somewhat crinkled and distorted. *Control:* Destroy infected plants.

15. *Dieback, Canker* (*callicarpa*) — See under Apple.
16. *Root Rots* — See (34) Root Rot under General Diseases. May be associated with nematodes (e.g., burrowing, root-knot).
17. *Crown Gall* (*lippia*) — See (30) Crown Gall under General Diseases.

LARCH [ALPINE, AMERICAN, EASTERN, EUROPEAN, JAPANESE, WESTERN], TAMARACK (*Larix*); GOLDENLARCH (*Pseudolarix*)

1. *Leaf Casts, Needle and Shoot Blights* — Primarily American and western larches. Needles are spotted, turn yellow then reddish-brown. Needles and shoot tips die back. Needles usually fall prematurely but some may cling over winter. Infected needles may be sprinkled with tiny white to black dots. *Control:* Gather and burn fallen needles in late autumn. If practical, spray ornamental larches several times, 2 weeks apart, using zineb, captan, maneb, fixed copper, bordeaux mixture, or lime-sulfur. Start when new growth is commencing.
2. *Needle Rusts* — Small, pale yellow to bright orange pustules on the new needles. Needles turn yellow, may be distorted and fall early. Causes little damage. Alternate hosts include willows, poplars (and aspens), birches, and alders. *Control:* Where practical, destroy nearby, worthless, alternate hosts. If serious enough, spray larches several times, 10 days apart, using zineb or ferbam. Start applications just before apple trees bloom.
3. *Wood Rots* — Cosmopolitan. Mostly occur on older, neglected trees which lack vigor. See under Birch, and (23) Wood Rot under General Diseases.
4. *Twig Blight* — Tips of new growth develop dead, curled leaves during cold, wet weather. A gray mold may cover affected areas. *Control:* Prune and space plants for better air circulation.
5. *Root Rots* — Cosmopolitan. Trees decline in vigor. Foliage is thin and sickly. Leaves may turn yellow, wither, and drop early. *Control:* See under Apple, and (34) Root Rot under General Diseases.
6. *Frost Injury* — Needles turn completely brown all at once. Shoot tips are usually most seriously affected. Needles later shrivel but tend to remain on the twigs for the balance of the season.
7. *European Larch Canker* (especially American and European larches, Goldenlarch) — Northeastern states, but believed to be eradicated. Cankers on larger trees develop gradually from year to year appearing as flattened, sunken, bowl-like, dead areas in the bark on the trunk or branches. Large amounts of resin may flow from cracked areas. Trees are distorted, swollen, and weakened. Stems and branches of young trees are quickly girdled and killed. The Japanese larch is relatively resistant. *Control:* Maintain trees in good vigor by proper fertilization and watering during dry periods. Plant in full sun in moist, well-drained soil. Avoid dry locations (e.g., sandy hillsides) and wounding or injuring the bark. Treat all bark wounds promptly with tree wound dressing (page 25). Cut down and burn all infected trees. If you suspect canker, contact your state or extension plant pathologist.
8. *Dwarf Mistletoes* — Northeastern and northwestern states. See (39) Mistletoe under General Diseases.
9. *Seedling Blight, Damping-off* — Seedlings are discolored and stunted. Often wilt and collapse. *Control:* Treat seed with thiram, captan, or dichlone. Plant in clean, well-drained soil. Avoid overwatering. Keep down weeds. Where practical, sterilize the soil before planting, using heat or chemicals (pages 437-44).

LARKSPUR — See *Delphinium*

LATHYRUS — See *Pea*

LATUCA — See *Lettuce*

LAUREL, MOUNTAIN — See *Blueberry*

LAVATERA — See *Hollyhock*

LAVENDER (*Lavandula*) — See *Salvia*

LAVENDER QUEEN — See *Snapdragon*

LAWN GRASS: WHEATGRASS (*Agropyron*); BENT, BENTGRASS, REDTOP (*Agrostis*); CARPETGRASS (*Axonopus*); BUFFALOGRASS (*Buchloe*); BERMUDAGRASS (*Cynodon*); CENTIPEDEGRASS (*Eremochloa*); FESCUE, FESCUE GRASS (*Festuca*); RYEGRASS (*Lolium*); BLUEGRASS (*Poa*); ST. AUGUSTINE GRASS (*Stenotaphrum*); ZOYSIA, ZOYSIAGRASS, JAPANESE LAWN GRASS (*Zoysia*)

1. *Leaf Spots and Blights, Melting-out, Dying-out, Fade-out, Anthracnose* — General. Purplish-black, dark brown, light gray, or tan spots on the leaves, leaf sheaths, and stems. Spots may be round, oval, or oblong in shape. With or without a prominent border. Usually follows cool, moist weather. Spots may enlarge and develop light-colored centers. Older leaves or entire plants may turn yellow, then brown and die.

Fig. 133. Leaf spot of Kentucky bluegrass.
(Courtesy Upjohn Co.)



Crowns and roots turn brown and rot. See Figure 133. Infected areas may have a general brownish undercast. Turf is thin and weak or killed out in round to irregular spots which enlarge during the summer. *Control:* Avoid heavy watering, frequent sprinkling, and overstimulation with fertilizer (especially with nitrogen) during the summer months. If practical, collect clippings. Mow regularly at the

height recommended for your area. Grass varieties differ in resistance. Apply phenyl mercury (but not to Merion bluegrass), Thimer, Tersan OM, Kromad, zineb, captan, phaltan, Acti-dione-thiram mixture, Ortho Lawn and Turf Fungicide, or Dyrene at 2-week intervals during spring, wet weather and continuing through July. Follow the manufacturer's directions. Mercury-containing fungicides frequently injure strictly southern grasses. Check with a lawn specialist. Soil drenches of zineb or captan (1 pound per 1,000 square feet), well watered in, are used by golf course superintendents to control Melting-out. Make several weekly applications starting in midspring. Apply chlordane (2 pounds actual) in 2 to 5 gallons of water per 1,000 square feet of lawn in early spring as grass starts to grow. This treatment controls crabgrass, earthworms, grubs, cutworms, sod webworms, ants, chiggers, mites, and fleas.

2. *Powdery Mildew* — General. Mostly on bluegrasses, fescues, and wheatgrass. Milky-white, grayish-white to brown mold patches on the leaves in shaded or poorly

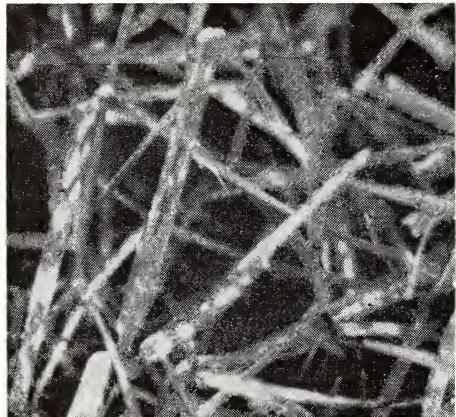


Fig. 134. Bluegrass powdery mildew. (Courtesy Upjohn Co.)

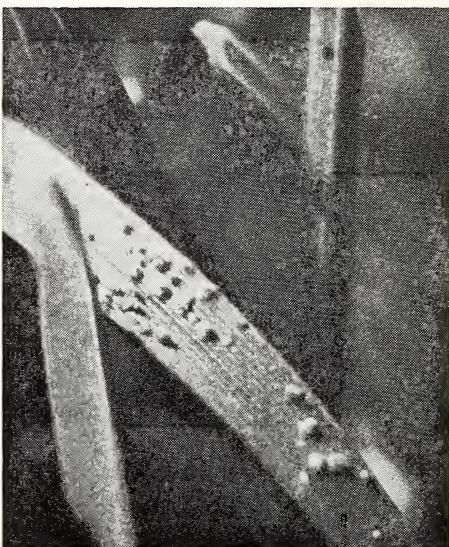


Fig. 135. Rust on Merion bluegrass. (Courtesy Upjohn Co.)

drained areas. Disease attacks occur chiefly in spring and fall during periods when nights are cool and days are warm. Leaves may turn yellow and wither. Plants may be weakened and die. Most serious on new plantings. See Figure 134. *Control:* If necessary, make two applications of sulfur, Karathane, or Acti-dione-thiram mixture, 10 days apart. Water and fertilize to maintain vigor. Follow the cultural practices as for Brown Patch (below).

3. *Rusts* (primarily Merion bluegrass, Bermudagrass, ryegrass, and St. Augustine grass) — General. Yellow-orange, reddish-brown, brownish-yellow or black, powdery pustules on the leaves and leaf sheaths. If severe, leaves may turn yellow, wither, and die. Turf may be thinned and weakened. Such turf is more susceptible to drought, winter injury, and other diseases. See Figure 135. *Control:* Fertilize with nitrogen and water deeply so grass is kept growing normally during the summer months. Otherwise apply zineb, Acti-dione-thiram mixture, manebe, dichlone, Kro-

mad, or thiram several times 7 to 10 days apart. Remove clippings if possible. Grow rust-resistant grasses.

4. *Brown Patch, Rhizoctonia Disease* — More or less circular patches, up to 3 feet in diameter, often with a grayish-black margin (especially on bentgrass). Grass leaves are first water-soaked, but soon dry, wither, and turn light brown. Roots and crowns may rot, especially in southern states. Turf may be thinned out in large areas, especially on southern grasses. Active in hot, humid weather when night temperatures are above 70° F. Bentgrasses are more seriously injured than coarser grasses. *Control:* Avoid overwatering and frequent sprinkling in late afternoon and evening. Prune dense trees and shrubs to increase air circulation. Avoid overfertilization during the summer months with a quickly available, high-nitrogen fertilizer. Provide for good soil drainage when establishing a new lawn. If possible remove the clippings after each mowing. Spray weekly in hot, humid weather using Calocure, Ortho Lawn and Turf Fungicide, Tersan OM, Thimer, or Calocure-thiram mixture. Terraclor (PCNB) 75 per cent has given good control on St. Augustine grass. Follow the manufacturer's directions.

5. *Dollar Spot* — Round, brown, bleached spots about the size of a silver dollar, to somewhat larger. Active in warm (60° to 85° F.), moist weather. Spots may run together forming large, irregular, straw-colored, sunken areas. See Figure 136. *Con-*

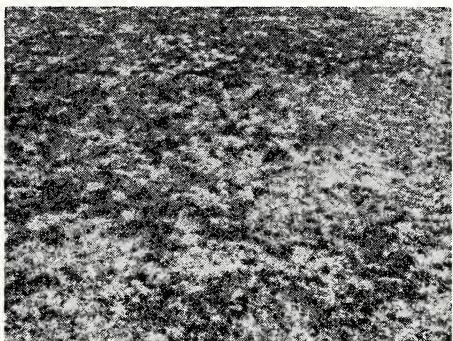


Fig. 136. Dollar spot. (Courtesy E. I. Du Pont de Nemours & Co., Inc.)

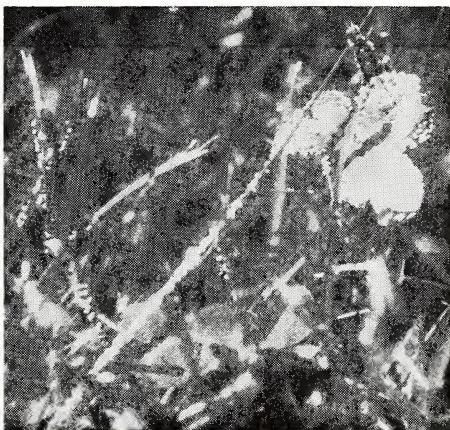


Fig. 137. Slime mold on Kentucky bluegrass. (Courtesy Upjohn Co.)

trol: Spray during the spring months and again in late summer and fall using Tersan OM, Thimer, Cadtrete, Panogen Turf Spray, Kromad, Caddy, Cadminate, phenyl mercury, Dyrene, Ortho Lawn and Turf Fungicide, Calocure, or Actidione-thiram. Follow the manufacturer's directions. Creeping bents are most susceptible. Maintain adequate to high fertility by following the recommended lawn feeding program for your area. Collect clippings. Same cultural practices as for Brown Patch (above).

6. *Slime Molds* — General. Small, colorless, white, gray, or yellow slimy masses grow up and over the grass surface in round to irregular patches, smothering or shading otherwise healthy turf. The masses dry to form bluish-gray, gray, black, or white powdery growths which can be easily rubbed off the grass blades. Slime molds suddenly occur following heavy watering or rains. Technically not a disease. See Figure 137. *Control:* Mow, rake, or brush affected areas and wash down with water. Spray as for Leaf Spots or Rusts (both above) if desired.

7. *Fairy Rings, Mushrooms* (or "Toadstools"), *Puffballs* — Rings or arcs of dark green, fast-growing grass which range in size from several inches to 50 feet or more in diameter. Sometimes an inner ring of thin or dead grass occurs. Fairy rings expand outward at a rate of a few inches to 2 feet or more per year. Toadstools, mushrooms, or puffballs may spring up around the edge of the ring following heavy watering or rains. See Figure 138. Dry patches in turf areas may actually be infested with the spawn of these fungi. *Control:* Bore holes $\frac{1}{2}$ to 1 inch in diameter,



Fig. 138. Fairy ring. Note dead areas in lawn and mushrooms (*Lepiota morgani*).
(Courtesy Dr. W. H. Bragonier)

- 4 to 5 inches apart, and at least 6 inches deep in the ring of stimulated grass and about 6 inches outside the ring. Fill the holes with a solution of Calo-clor, Calocure, Fungchex, or Woodridge Mixture 21 (2 ounces in 5 gallons), or use phenyl mercury according to the manufacturer's directions. Usually this is 1 to 2 ounces in 5 gallons of water. Add 2 ounces of household detergent per 5 gallons of water to aid in penetration. Use a battery bulb or funnel in filling the holes to avoid spilling the mercury solution on the grass. Water in the chemical liberally. Repeat the treatment monthly for a season. Or remove the sod and sterilize the soil beneath using a soil fumigant (pages 440-44). Keep the lawn well fertilized and watered so that rings do not show so distinctly.
8. *Snow Scald, Gray Snow Mold* — General in northern states. More or less circular, dead, bleached areas, up to about 2 feet in diameter. May be covered at first with a bluish-gray to almost black mold growth. Found in winter or early spring in shaded, wet areas or where snow is slow to melt. Usually associated with melting snow. A crustlike mat may form where the grass has been left long. See Figure 139. *Control:* In northern states avoid fertilizing after about September 15. Before the



Fig. 139. Snow mold. (Courtesy E. I. Du Pont de Nemours & Co., Inc.)

first heavy snow is forecast or before cold drizzly weather apply Tersan OM, Thimer, Calocure, Calo-clor, thiram, or phenyl mercury following the manufacturer's directions. Repeat during a midwinter thaw. Spray during the growing season as for Leaf Spots, Brown Patch, and Dollar Spot (all above).

9. *Fusarium Patch, Pink Snow Mold* — Small, round, brown patches, usually 1 to 2 inches in diameter. Spots may sometimes enlarge to a foot or more across. May be covered at first with a white to pink mold growth. Usually associated with melting snow but attacks also occur during cold, drizzly weather (up to about 65° F.). *Control:* Same as for Snow Scald (above). Phenyl mercury and Caddy applied alternately at 2-week intervals during the spring and autumn, and monthly during the rest of the year, in western Washington gave excellent control. Somewhat resistant bentgrasses: Penn-cross, Cohansey, and Pennlu. Liming increases the severity of disease.
10. *Grease Spot, Spot Blight, Pythium Disease, Cottony Blight* — Widespread and destructive in the southeastern states. Round, reddish-brown spots, several inches in diameter, with blackened, greasy borders. Occurs in hot, muggy weather (90° to 110° F.) on heavy, poorly drained areas. Spots often run together to form streaks. The disease is apparently spread by mowing and flowing water. Spots dry out and become bleached. The disease may spread rapidly, killing out turf. In southern states, small white spots, which later become "cottony" are common, especially on ryegrass during the late fall, winter, and early spring. The roots are usually attacked and die back. *Control:* Follow the cultural practices as for Brown Patch (above). Apply mixture of Acti-dione and captan or zineb or use Dexon, captan, zineb, Acti-dione, or Kromad alone during hot, humid periods. Start spraying with the first evidence of disease. Frequent applications are necessary (1 or 2 per week). Follow the manufacturer's directions. In the southeastern states where Cottony Blight is severe, check with your extension or state plant pathologist for recommendations. Apply Dexon when planting ryegrass. Repeat 1 week later.
11. *Root-feeding Nematodes* (awl, burrowing, cyst, cystoid, dagger, lance, needle, pin, reniform, ring, root-lesion or meadow, sheath, sheathoid, spiral, stem, sting, stubby-root, stunt or stylet) — Turf lacks vigor. Often appears stunted and yellowed with dead and dying areas. Injury is easily confused with fertilizer burn, a soil deficiency, poor soil aeration, drought injury, insects, and other types of injury. Grass may appear sickly and off-color. Does not respond normally to water and fertilizer. Grass

blades dying back from the tips may be interspersed with apparently healthy leaves. Roots may be swollen, stunted, bushy, "stubby," and dark in color. Turf may later thin out, wilt, and "melt out." Severity of symptoms varies with the population of nematodes feeding on the roots. Plant parasitic nematodes can be identified only by taking suspected turf plugs and subjecting them to an analysis by a competent nematologist. *Control:* Keep grass growing vigorously by watering and fertilizing as recommended for your area. If necessary, apply soil drenches of Nemagon, Fumazone, or VC-13 Nemacide following the manufacturer's directions.

12. *Chlorosis, Yellowing* — A problem in moderately to highly acid or alkaline soils. Turf areas are irregularly yellowed and stunted. Caused by a minor element deficiency, usually iron. *Control:* Apply $\frac{3}{4}$ to 1 pound of iron sulfate or iron chelate (Versenol Iron Chelate, Sequestrene Iron Chelate) in 5 to 10 gallons of water per 1,000 square feet. Repeat the treatment as necessary to maintain normal green turf color. Some lawn fungicides (e.g., Kromad, Formula Z, and Acti-dione Ferrated) already have iron sulfate in the spray mixture.
13. *Algae, Green Scum* — A green to blackish scum forms on bare soil or thinned turf. Occurs in low, wet, shaded, or heavily tracked and compacted spots. Technically not a disease. Dries to form a thin, black crust which later cracks and peels. *Control:* Same cultural practices as for Brown Patch (above). Provide for good soil drainage. Aerify. Maintain turf in good vigorous condition. Where necessary, apply a spray of copper sulfate, 2 ounces in 3 to 5 gallons of water to 1,000 square feet of lawn.
14. *Smuts* — General. Long or short stripes or spots in the leaves which rupture and release dark brown or black powdery masses. Leaf tissues may be shredded and withered. *Control:* Dig out and burn affected plants, where practical. Merion and Kentucky are more susceptible than other bluegrasses. Spring or fall soil drenches of nabam (1 part of 22 per cent nabam in 400 of water) appears promising. Zineb may also be effective.
15. *Red Thread, Pink Patch* — Northern coastal regions, mostly on fescues, bents, bluegrasses, and ryegrass. Pink patches of dead grass 2 to 6 inches or more in diameter develop during cool, rainy weather in spring and fall. Usually only the leaves are affected. If severe, patches turn brown and plants die. Characteristic bright coral-pink to red threads "bind" leaves together in moist weather. *Control:* Maintain adequate fertility. Same chemicals as for Dollar Spot (above). Apply at about 2-week intervals. Collect clippings.
16. *Copper Spot* (bents, redtop) — Humid coastal areas in acid soils. More or less circular, coppery-red to orange spots, 1 to 3 inches in diameter. Spots may run together forming irregular, copper-colored areas. Disease attacks occur during warm (65° to 85° F.), wet periods. *Control:* Apply phenyl mercury, Calocure, Caddy, Ortho Lawn and Turf Fungicide, Cadminate, Thimer, Cadrette, or Kromad according to the manufacturer's directions.
17. *Gray Leaf Spot of St. Augustine Grass* — Destructive in hot or humid periods. Small brown dots on the leaves which later enlarge to form roundish, dirty-yellow, or ash-colored leaf spots and stem cankers with reddish-brown, purple, or water-soaked borders. Spots may be covered with a grayish mold in humid weather. Turf is unsightly and more susceptible to drought and other types of damage. *Control:* Apply phenyl mercury, Calocure, Thimer, Tersan OM, captan, Kromad, chloranil, or thiram at 8- to 10-day intervals following the manufacturer's directions.
18. *Fusarium Blight of Bluegrass* — Northeastern states. Small tan or straw-colored spots develop in lawns in early summer. Spots later enlarge and run together causing large areas of the lawn to turn brown. *Control:* Same as for Leaf Spots (above).

19. *Spring Dead Spot of Bermudagrass* — Apparently fairly widespread in well cared for turf. Conspicuous, bleached, round dead spots are present in the spring. Spots vary in size from a few inches to 3 or more feet in diameter. Roots are black and rotted. Sometimes the center of the spots may survive resulting in "doughnuts." Spots usually remain dead for a number of years. Such areas become invaded by weeds and other grasses. Disease is most severe on U-3 Bermudagrass although African, Common, Tiffine, and Tifgreen are also infected. May be confused with snow mold, winter, or insect injury. *Control:* Dieldrin soil drenches in late fall and early winter have proved effective. Check with your state or extension plant pathologist.
20. *Moss* — Occurs in lawn areas low in fertility with poor drainage, high soil acidity, too much shade, watered improperly, heavily compacted, or a combination of these factors. *Control:* Remove by hand raking. Follow the cultural practices as for Brown Patch (above) and Compacted Areas (below). Have a soil test made and follow the instructions in the report.
21. *Seed Rot, Seedling Blight, Damping-off* — General. Seeds rot. Stand is thin in patches. Seedlings stunted, water-soaked, then turn yellow to brown. May wilt and collapse. Surviving plants are weakened. Stand is slow to fill in. *Control:* Plant fresh, best quality seed in a well-prepared seedbed of high fertility. Provide for good soil drainage when establishing a new lawn. Treat seed with captan or thiram. Avoid overwatering after planting. If possible, plant in late summer or early fall. After sowing, apply a dilute spray of Kromad, captan, thiram, or zineb (4 ounces in 3 gallons of water to cover 1,000 square feet). Avoid low spots in the seedbed.
22. *Chemical Burning* — Agricultural chemicals (e.g., fertilizers, pesticides, and hydrated spray lime) may injure grass if improperly applied. Burned areas may occur in spots or streaks, or the entire lawn may be "scorched." Prevent injury by following the instructions printed on the package label. Apply fertilizers evenly in recommended amounts when the grass is dry. Then water in the fertilizer immediately. The use of a lawn spreader is highly recommended. Ground agricultural limestone is safer to use on lawns than hydrated lime.
23. *Female Dog Injury* — Injury from dog urine may resemble brown patch or snow mold. Affected areas are often more or less round and up to a couple of feet in diameter. Injured grass turns brown or straw-colored and usually dies.
24. *Buried Debris* — A thin layer of soil over buried rocks, lumber, bricks, plaster, or concrete dries out rapidly in dry summer weather and may resemble disease. Dig up suspicious areas and remove the cause.
25. *Compacted Areas* — Thin turf or bare spots in heavily tracked areas. Waterlogged and heavy-textured soils become packed and later bake hard if walked on constantly. Correct by aerifying the soil using a hand aerifier or tined fork. Aerating machines are sold or rented by garden supply stores as well as by many nurserymen and golf courses. If necessary, fertilize and reseed. Reduce foot traffic by putting the area into a walk or patio or erect a fence.
26. *Insect Injury* — Numerous insects, including grubs, ants, sod webworms, chinch bugs, leafhoppers, and others may damage turf. Insect injury may closely resemble one or more lawn diseases. For information concerning lawn insects and their control, contact your county agent or extension entomologist. See under Leaf Spots (above).
27. *Mosaic* (primarily bluegrass) — Yellowish or light and dark green mottling and striping of leaves. *Control:* None suggested.
28. *Downy Mildew* (Bermudagrass) — Southwestern states. Leaf tips have short, black, dead areas. Causes little damage.

LAWSON CEDAR — See Juniper

LAYIA — See Chrysanthemum

LEADPLANT — See False - indigo

LEADTREE — See Honeylocust

LEATHERLEAF — See Blueberry

LEATHERWOOD, WICOPY (*Dirca*)

1. *Rust* — Eastern half of the United States. Small yellowish spots on the leaves. Alternate host is *Carex*. *Control*: Destroy the alternate host. If necessary, apply ferbam or zineb several times, 10 days apart, starting 1 or 2 weeks before rust normally appears.
2. *Sooty Mold* — Black moldy blotches on the leaves and twigs. *Control*: Control insects with malathion sprays.

LEBBEK — See Honeylocust

LEBOCEDRUS — See Juniper

LEDUM — See Labrador - tea

LEEK — See Onion

LEIOPHYLLUM — See Labrador - tea

LEMAIREOCEREUS — See Cactus

LEMON — See Citrus

LEMON MINT — See Salvia

LEMON - VERBENA — See Lantana

LENTIL (*Lens*) — See Pea

LEONOTIS — See Salvia

LEOPARDSBANE — See Chrysanthemum

LEPIDIUM — See Cabbage

LETTUCE [COS, HEAD, LEAF, ROMAINE], CELTUCE (*Latuca*); ENDIVE, ESCAROLE, CHICORY (*Cichorium*); CARDOON, ARTICHOKE or GLOBE ARTICHOKE (*Cynara*); JERUSALEM - ARTICHOKE (*Helianthus*); BLACK - SALISFY (*Scorzonera*); SALSIFY, VEGETABLE OYSTER (*Tragopogon*)

1. *Bottom Rots, Drop, Head or Tuber Rots, Southern Blight, Stem or Crown Rot* (celtuce, chicory, endive, escarole, Jerusalem-artichoke, lettuce) — General and destructive. Head wilts and rots. Often starts with the lowermost leaves. May become slimy and foul-smelling, or covered with a dense, white, gray or blue-green mold growth. Upright lettuce varieties are often less seriously damaged. *Jerusalem-artichoke* varieties differ in resistance. Heads or tubers continue to rot after harvest. *Control*: Avoid overwatering and overcrowding. Do not plant in wet, poorly drained soil. Keep down weeds. Three- or 4-year rotation. Harvest and refrigerate promptly. Store only sound, disease-free heads or tubers. Destroy crop refuse after harvest. Plow cleanly and deeply. Polyethylene mulches under the plants in strips

will largely prevent head rots. Or apply Terraclor as a spray or dust to *head lettuce* only, just before thinning (plants 2 to 3 inches tall). Repeat 10 days later. Follow the manufacturer's directions. Wet the lower leaves and soil under the plants. Control insects with malathion sprays. Grow upright lettuce varieties and types (e.g., Romaine or Cos, Iceberg). Treat seedbed soil as for Seed Rot (below).

2. *Tipburn* — General and destructive, especially on summer and indoor lettuce crops. Most severe on head lettuce during hot, humid periods. Margins of tender leaves turn brown to black and dry. Slimy soft rots may follow. *Control:* Plant in well-drained soil. Cultivate deeply and frequently to avoid soil packing. Use fertilizers sparingly. Grow tolerant *lettuce* varieties: Alaska, Arizona Sunbright, Blackpool, Climax, Cornell 456, Cosberg, Golden State C and D, Great Lakes 118, 366, and 659, Great Lakes Emerald, Imperial 44, 410 and 456, Jade, New York 515 and PW55, Pennlake, Premier Great Lakes, Progress, Resistant Grand Rapids, Ruby, Salad Bowl, Sunblest No. I, Sweetheart, and Vanguard.
3. *Aster Yellows, White Heart, Curly Dwarf* — Widespread. Center leaves become dwarfed, twisted, and yellowed. Lettuce heads are loose and lightweight — or may not even form. Plants dwarfed, "bunchy," and yellowish. May die prematurely. *Control:* Keep down weeds in and around the garden. Destroy the first infected plants. Plant at the time recommended for your area. Control leafhoppers which transmit the virus. Apply methoxychlor and malathion at about 5-day intervals.
4. *Mosaics* (primarily lettuce) — General. Leaves mottled yellow and light green, ruffled, or even distorted and dwarfed. Older plants are stunted, dull green to yellow or brown. May die or not. May not form a head. Symptoms are often masked in hot weather. *Control:* Plant indexed, mosaic-free lettuce seed. Destroy young, infected plants when first seen. Keep down weeds. Destroy plant refuse after harvest. Rotate. Control aphids with malathion. Apply at 3- to 5-day intervals. Tolerant *lettuce* variety: Parris Island Cos.
5. *Downy Mildew* (artichoke, celtuce, chicory, endive, escarole, Jerusalem-artichoke, lettuce, spinach) — General during cool (43° to 53° F.) , humid weather. Pale green or yellowish areas develop on the upper leaf surface. A fluffy, whitish to bluish-gray mold may form on the corresponding underleaf surface during cool, damp weather. Later the spots turn brown. When severe, plants may be dwarfed and yellow with the outer leaves turning brown and dying. See Figure 20B and D under General Diseases. *Control:* Plant disease-free seed grown in the western states. In the seedbed, increase air circulation and light. Avoid overcrowding, overwatering, overfertilizing, and water splashing on the leaves. Rotate. Collect and burn plant debris after harvest. Do not work among wet plants. Plant in well-drained soil where air circulation is good. The seedbed soil should be treated with heat or chemicals before planting (pages 437-44). Apply maneb or zineb at 5- to 7-day intervals in damp weather, especially in the seedbed. Keep down the humidity. Normally resistant *lettuce* varieties, where adapted: Arctic King, Bath Cos, Big Boston, Grand Rapids, Imperial [strains D, 44, 152, 410, 615, 847, 850], Salad Bowl, and Valverde. Keep down weeds.
6. *Fusarium Yellows, Wilt* (lettuce) — Leaves turn yellow, wilt, and drop starting at the base of the plant. Dark brown streaks inside stems and larger veins. *Control:* Long rotation. Plant in well-drained soil.
7. *Gray-mold Blight* — General in lettuce hot beds and indoors in damp weather. Grayish-green or brownish water-soaked areas on the lower leaves, stem or flower head (buds) of globe artichoke. May be covered with a coarse gray mold in damp weather. Plants may collapse. Heads may rot in the field or after cutting. Seedlings may wilt and collapse. *Control:* Treat in the seedbed as for Downy Mildew.

- (above) and Seed Rot (below). If necessary, dust or spray with mixture of Terraclor and captan. Follow the manufacturer's directions. Indoors, keep water off the foliage and increase air circulation. Store heads as cool and dry as practical.
8. *Lettuce Big Vein* (lettuce) — Widespread. Most severe in cool seasons. Plants may be stunted with crinkled, yellowed, and brittle leaves. Leaf veins are swollen and light yellow in color. Yellow spots may develop in young leaves with irregular, brown blotches on the older leaves. Heads may not form or are reduced in size and delayed in maturity. The big vein fungus can carry tobacco necrosis virus to healthy plants. *Control:* Plant in clean or sterilized soil (pages 437-44) which is well-drained. Keep the soil on the dry side. Grow transplants at a temperature of 75° F. or above, or plant outdoor lettuce as a midsummer or fall crop. Treating the soil with Terraclor as for Seed Rot (below) and Bottom Rot (above) may be beneficial. Resistant varieties: Caravan and Forty-niner.
9. *Bacterial Leaf Spots and Rots, Bacterial Wilt, Marginal Blight* (chicory, endive, Jerusalem-artichoke, lettuce) — Widespread in wet weather. Leaf margins may rot and turn a brownish-black and later become thin and brittle. Small, water-soaked, yellow to yellowish-red, brown, or black spots or large, irregular blotches may develop in the leaves. Spots may remain small and dry or enlarge and become soft and moist. Leaves and stems may wilt and rot. Plants may be yellowed and stunted. *Control:* Same as for Downy Mildew (above). Avoid splashing soil on plants when watering. Control insects by using methoxychlor and malathion sprays.
10. *Seed Rot, Damping-off* — General. Seeds rot. Stand is poor. Seedlings wilt and collapse from a rot at the soil line. Roots are brown and rotted. *Control:* In the seedbed, mix a combination of Terraclor 20 per cent dust and captan 7½ per cent dust into the top 4 inches of soil. Use ½ cup of each mixed (rototilled) into 100 square feet of bed. Or apply a drench of Terraclor 75 per cent and captan 50 per cent (0.8 ounce of each in 10 gallons of water to 200 square feet of seedbed). Otherwise treat as for Downy Mildew (above). If stand has been poor, dust *lettuce* seed with chloranil, thiram, captan, or Semesan. Dust *chicory*, *endive*, *escarole*, and *salsify* seed with thiram or Semesan.
11. *Rusts* — Small, bright yellow to yellow-orange spots on the leaves. Pustules may later be reddish-brown and powdery. Leaves may wither. *Control:* Same as for Downy Mildew (above). Alternate hosts: sedges (*Carex spp.*), or none. Destroy all sedges within 100 yards of the garden area, where practical.
12. *Powdery Mildew* — General. Primarily a lettuce problem on the West Coast. Small to large patches of whitish mildew on leaves. May cover the foliage in overcast, damp weather. Leaves later curl and turn yellow, then brown and die. *Control:* In problem areas, plant resistant *lettuce* varieties: Arctic King, Bath Cos, Big Boston, Imperial strains, and Salad Bowl. Several sulfur dusts or sprays, 10 days apart, should keep mildew in check. Apply as necessary.
13. *Root Rots, Stunt, Wilt* — Lower leaves a dull, dark green. Later wilt, wither, and die. Plants stunted with poor heads. Inside of roots is brown or black. Roots are rotted. Seedlings wilt and collapse. Often associated with nematodes. *Control:* Avoid planting in heavy, cold, wet soil. Rotate. Fertilize and water plants to maintain vigor. Avoid fertilizers high in ammonia or nitrite. Resistant *lettuce* varieties and types: Big Boston, Grand Rapids, Cos, Simpsons Curled, and White Boston. Control insects by malathion sprays.
14. *Other Fungus Leaf Spots or Blights, Anthracnose* — Spots of various sizes and colors which may enlarge and run together, forming irregular blotches. Spots may drop out leaving shot-holes. Leaves may wither and die starting usually with the oldest ones. Plants may appear sickly and stunted. *Control:* Same as for Downy

Mildew (above). Spray weekly in the field during rainy periods using zincb, maneb, or fixed copper. Keep plants growing vigorously. Plant disease-free seed or treat as for Seed Rot (above). Collect and burn plant debris after harvest. Lettuce varieties differ in resistance.

15. *Lettuce Brown Blight* — Pale yellow or brown, irregular spots and blotches develop on the inner leaves. Spots later enlarge. Plants become stunted, flat, and rosette-like. The leaves on such plants gradually turn brown starting at the base. Many plants die before harvest. *Control:* Plant resistant varieties: Imperial and Great Lakes strains, or Big Boston.
16. *Root-knot* — General over much of the United States. See under Bean, and (37) Root-knot under General Diseases.
17. *Slime Molds* — See under Lawngrass. Control measures are not needed.
18. *Spotted Wilt* — Irregular, brown, dead spots in the inner leaves. Outer leaves droop and are stunted. Leaves may twist causing the head to lean one way. Leaves and entire plant may show a general yellowing. Plants often die early. *Control:* Same as for Mosaics (above). Control thrips which transmit the virus. Use malathion.
19. *Curly-top* (lettuce) — See (19) Curly-top under General Diseases.
20. *White-rust* (primarily salsify and black-salsify) — General. Often destructive in warm, moist weather. Foliage is twisted and distorted. Numerous whitish pustules, which yellow with age, break out on all aboveground plant parts. *Control:* Rotate. Keep down goatsbeard and other related weeds. Pick off and burn spotted leaves. Spraying as for Downy Mildew (above) should be beneficial.
21. *Leaf and Stem Nematode* (salsify) — See (20) Leaf Nematode under General Diseases.
22. *Verticillium Wilt* — See (15B) Verticillium Wilt under General Diseases.
23. *Crown Gall* (Jerusalem-artichoke, lettuce) — See (30) Crown Gall under General Diseases.
24. *Scab* (salsify) — See (14) Scab under General Diseases.
25. *Other Root-feeding Nematodes* (e.g., lance, naccobus, pin, reniform, root-lesion, spiral, sting, stubby-root, stylet or stunt) — Associated with stunted, sickly plants. Roots often short, stubby, bushy, and discolored. *Control:* Same as for Root-knot (above).

LEUCAENA — See Honeylocust

LEUCOJUM — See Daffodil

LEUCOPHYLLUM — See Texas Silver Leaf

LEUCOTHOË — See Labrador - tea

LIATRIS — See Chrysanthemum

LIBOCEDRUS — See Juniper

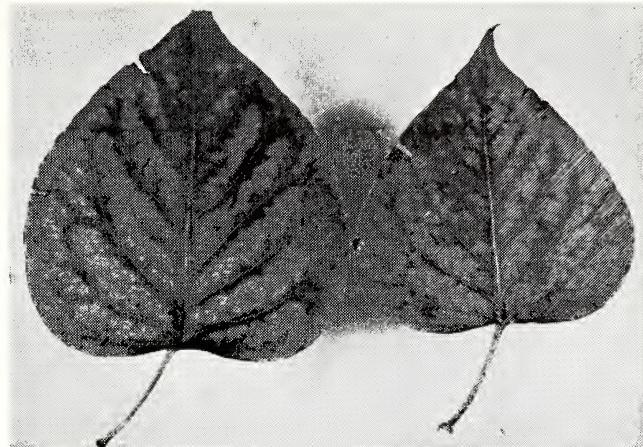
LIGUSTRUM — See Privet

LILAC [AMUR or MANCHURIAN, CHENGTU, CHINESE, COMMON or OLD - FASHIONED, EVANGELINE, HIMALAYAN, HUNGARIAN, HYBRID, JAPANESE, JAPANESE TREE, KOREAN EARLY, LITTLE LEAF, NODDING, PEKING, PERSIAN, PINK PEARL, ROUEN] (Syringa)

1. *Powdery Mildew* — General but not serious. Grayish-white mold patches or coating on the leaves from midsummer on. Most common on the lower or shaded leaves.

- See Figure 21C under General Diseases. *Control:* Apply Karathane, sulfur, or Actidione several times, 10 days apart, starting when mildew is first seen.
2. *Shoot Blights, Dieback, Stem and Twig Cankers* — Common and severe in wet spring weather where plants are shaded or crowded. Leaves turn a blackish-brown and cling to the stem or drop early. Flower buds or blossoms wilt and turn brown to black. Dark brown to black, elongated cankers on the stem. Shoots wilt and may die back to the ground. Often associated with stem borers. *Control:* Prune shrubs annually for good air circulation. Avoid overcrowding. Prune out and burn blighted portions when found. Swab pruning tools with 70 per cent denatured alcohol between cuts. Apply zineb, maneb, fixed copper, or bordeaux mixture (4-4-50) before spring wet periods starting as the leaves begin to unfold. Spray after bloom as for Leaf Spots (below). Avoid overfertilizing with manure or a high-nitrogenous fertilizer and planting close to rhododendron and privet. Spray with dieldrin to control borers. Check with your county agent or extension entomologist regarding timing of sprays for your area.
3. *Leaf Spots, Leaf Blotch or Blights, Anthracnose* — Small to large, variously colored spots, often with dark margins. Spots may later drop out leaving irregular ragged holes. *Control:* If serious enough, apply zineb, maneb, captan, or fixed copper several times, 7 to 10 days apart. Start just after lilacs have bloomed. Applications may also be needed before summer and fall rainy periods in wet seasons.
4. *Gray-mold Blight, Botrytis Blight, Blossom Blight* — Buds and blossoms may turn light brown and water-soaked, rot, and become covered with a coarse, tannish-gray mold. Common in humid, wet areas. May follow frost or other injury. *Control:* Same as for Shoot Blights and Leaf Spots (both above).
5. *Root Rots* — Certain branches, or the entire shrub may die. Underground parts are rotted. See under Apple. May be associated with root-feeding nematodes (e.g., citrus, dagger, lance, root-lesion, spiral, stem, stylet or stunt). *Control:* Carefully dig up and burn affected plants, including as many of the roots as possible. Do not replant in the same soil without first drenching the soil as for Verticillium Wilt (below).
6. *Wood Rot* — See under Birch, and (23) Wood Rot under General Diseases. Commonly follows borers and other types of injuries.
7. *Mosaic* — Virus complex. Leaves are dwarfed, puckered, folded, and mottled or spotted with yellow. May closely resemble Graft Blight (below) and a soil deficiency. Symptoms tend to disappear during certain seasons. *Control:* Dig up and destroy infected plants when found to be mosaic.
8. *Ringspot* — Pale green to yellow rings, spots, lines, and broad bands on the leaves. Leaves may be distorted and ragged with holes. *Control:* Same as for Mosaic (above).
9. *Witches'-broom* — On common lilac the leaf veins are first yellow and clear. Several months to a year later, numerous, slender, lateral shoots with dwarfed leaves are formed producing a witches'-broom. On Japanese lilac several (2 to 6) slender shoots, usually near the top of the plant, branch freely and bear dwarfed leaves which are often twisted and rolled. *Control:* Same as for Mosaic (above).
10. *Verticillium Wilt* — Leaves on one or more stems are pale, wilt, and fall early starting at the base and spreading upward. Clusters of leaves at the stem tip may remain hanging for a long time. Stems show brownish-green streaks under the bark. Branches die back. Slightly infected shoots are stunted and thickened with stunted flower clusters. *Control:* Dig up and burn infected plants, roots and all. Avoid planting in the same location for 5 or 6 years without first drenching the soil with Vapam or V.P.M. Soil Fumigant following the manufacturer's directions.

Fig. 140. Graft incompatibility of lilac. (Iowa State University photo)



11. *Graft Blight, Incompatibility Disease* — Occurs where lilac is grafted on privet. Leaves are dwarfed, irregular, rolled, curled, or cupped. Leaves are usually yellowish, later brown, at the margins and between the veins. Plants are stunted. Resembles a nutrient deficiency or Mosaic. See Figure 140. *Control:* Propagate lilac on its own roots or use a piece root-graft. Check with your local nurseryman if you are propagating lilacs.
12. *Frost Injury* — Freezing temperatures in late spring may cause the leaves to become torn along the veins in an irregular pattern.
13. *Root-knot* — See under Peach, and (37) Root-knot under General Diseases.
14. *Crown Gall* — See (30) Crown Gall under General Diseases.

LILY [BERMUDA, CANDLESTICK, EASTER, GOLDENBANDED, HANSON, JAPANESE EASTER, MADONNA, MARTAGON, MICHIGAN, REGAL or ROYAL, SHOWY, TIGER, TURKS-CAP, WILD (ORANGE-RED or WOOD), WILD YELLOW or CANADA], also *Lilium columbianum*, *L. formosanum*, *L. henryi*, *L. hollandicum*, *L. humboldtii*, *L. japonicum*, *L. pardalinum*, *L. rubrum*, *L. tenuifolium*, *L. testaceum*, and *L. washingtonianum* (*Lilium*); LILY - OF - THE - VALLEY (*Convallaria*); BELLWORT, MERRYBELLS (*Uvularia*)

1. *Botrytis Blights, Gray-mold Blight, Stem Rot* — General and serious on most lilies in damp weather. Symptoms variable. Yellowish to reddish-brown or dark brown (sometimes light gray), oval to round spots on the leaves, stems, and flowers. Spots may enlarge and run together, blighting the whole leaf. Leaves may blacken, wither, and hang limply, often starting at the base of the stem. The tip of the shoot or the entire top may die and bend sharply downward. Bulb or rhizome may rot. Plants often stunted. Buds rot or open to distorted, brown-flecked flowers. A coarse gray mold may grow on affected parts in damp weather. See Figure 19C under General Diseases. *Control:* Carefully collect and destroy infected parts as they occur. Burn tops in the fall. Space plants. Increase air circulation. Keep down weeds. Plant best quality, disease-free bulbs (or rhizomes) in a sunny spot in well-drained soil. Avoid splashing water on the foliage when watering. Avoid overfertilizing with nitrogen. During cool, wet weather apply 4-2-50 bordeaux mixture (4 ounces of copper sulfate and 2 ounces hydrated spray lime in 3 gallons of water) at 7- to 10-day intervals. Add detergent or spreader-sticker to ensure wetting of the foliage. Cover all aboveground parts with each spray. Regal, Hanson, Martagon, and

Goldenbanded *lilies* are usually much more resistant than Madonna, Showy, Tiger, and Easter. Indoors, increase light and circulation. Lower the humidity. Spray buds and early blooms lightly with zineb. Keep water off the foliage.

2. *Bulb Rots, Scale Rots, Root Rots* — Cosmopolitan and serious. Plants stunted and sickly with rotted bulb and roots. Foliage turns yellow or purple. Stems may dry up from the base with leaves withering and falling. Flowers may be blasted and fewer in number. Often associated with viruses, nematodes, and mites. Mold growth on stored bulbs. Bulbs may be wet, slimy, and foul-smelling, soft or dry and punky or "chalky." Marginal, brown areas may develop on certain leaves as they get older. Lily bulb scales may show discolored "scabby" spots. Bulbs are unsightly. See Figure 49C under General Diseases. *Control:* Plant large, highest quality bulbs or rhizomes in open, well-drained soil, sterilized if practical. Before planting, soak *lily* bulbs 30 minutes in a mixture of Terraclor 75 (1 ounce in 6 gallons of water) and captan 50 or ferbam 76 (2 ounces in 6 gallons). Dig up and destroy all infected plants and surrounding soil. Avoid wounding bulbs or growing plants. Five- to 6-year rotation. Avoid overwatering. Practice balanced soil fertility based on a soil test. Mixing Terraclor into the furrow before planting has proved beneficial. Follow the manufacturer's directions. Keep bulbs cool in storage.
3. *Mosaics, Mottle, Flower Breaking* — Serious and widespread on lilies. Symptoms variable. Leaves mottled, yellow, and light and dark green or with yellowish (or brown) streaks. Leaves may be stunted, curled, twisted, and narrowed. Flowers are often blotched or "broken." Some species are stunted or killed; die from root and bulb rots. Symptoms may fade as plants get older. Certain lilies carry the viruses but show no symptoms. Often confused with various mineral deficiencies, but symptoms are usually more uniform. See Figure 141. *Control:* Destroy infected plants when first seen as they will not recover. Plant only the largest, virus-free bulbs from a reputable nursery, or grow from seed. Control aphids which transmit the viruses. Use lindane or malathion. Keep down weeds. Resistant *lily* species: Hanson and *Lilium pardalinum*. Avoid growing *L. formosanum* and *L. rubrum* near other lilies or near "broken" or mosaic-infected tulips. Grow Goldenbanded and *L. rubrum* lilies separately. Grow *L. henryi* from seed.
4. *Rosette, Yellow Flat* — Very destructive. Lily plants may be dwarfed. The upper leaves pale green or yellowish and tightly curled downward forming a basal "rosette." Leaves are sometimes twisted sideways and are distorted. Often confused with frost injury, water-logged soil, aphids, or root and bulb rots. Bulbs progressively grow smaller each year. Plants rarely flower and never recover. *Control:* Same as for Mosaics (above).
5. *Fleck* (*lily*) — Plants stunted, distorted, and short-lived. Blocklike, "translucent windows" or white, yellowish or brown flecks in leaves. Leaves tend to curl and twist. Flowers are fewer in number and short-lived. May be twisted and streaked. *Control:* Same as for Mosaics (above).
6. *Ringspot* (Easter, regal, and tiger lilies) — Dark, ringlike patterns on leaves which soon become dead areas which spread throughout the plant. No flowers are produced. Plants twisted and stunted or killed outright. Hybrid lilies may show only a faint mottling. *Control:* Same as for Mosaics (above).
7. *Noninfectious Chlorosis* — Plants stunted. Yellowish leaves with green veins. May closely resemble the Mosaic complex except the yellowish patterns are more regular and more yellow. *Control:* Common in alkaline soils. Have the soil tested. Add acid fertilizer and a solution of ferrous sulfate to the soil. For fast results, spray the foliage with ferbam, iron (ferrous) sulfate, or an iron chelate.

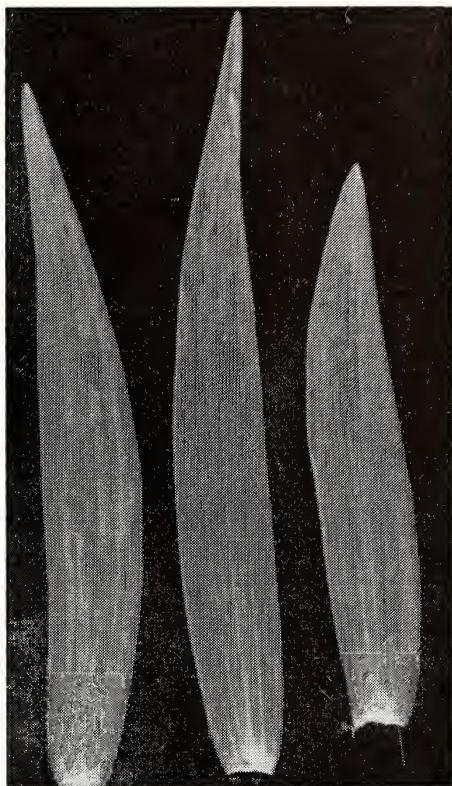


Fig. 141. Lily mosaic.

8. *Stem Rots or Canker, Foot Rots, Stump Rot, Root Rots* — Cosmopolitan. Plants often stunted and sickly. May wilt gradually or suddenly, wither, often collapse. Stem rots at the ground line. Roots are rotted. Tips of young plants may wither. *Control:* Same as for Bulb Rots. In addition, wash out mud from the crowns as plants emerge. Dipping bulbs just before planting in a mixture of Terraclor and ferbam or captan may be beneficial. See under Bulb Rots (above).
9. *Rusts* — Widespread. Yellow spots on the upper leaf surface with yellow-orange, reddish-brown or black, powdery pustules on the corresponding underleaf surface. Alternate hosts: *Sporobolus* (ribbon or reed grasses) or none. *Control:* Destroy infected leaves when found. Where serious, apply ferbam, zineb, maneb, or dichlone at 10-day intervals. Destroy weed hosts.
10. *Stalk Rot, Southern Blight* — May be serious in southern states in heavy, wet soils. Chalky white rot of bulb with white, fanlike mold patches. Plants wither and die in patches. Regal lily is very susceptible. *Control:* Same as for Bulb Rots (above). Resistant lily varieties: Easter and Showy.
11. *Leaf and Bud (Bulb) Nematode, "Bunchy Top," Dieback* (lily) — Pacific Northwest. Symptoms variable. Leaves may be blotched yellow and green. Leaves then turn yellow, bronze to dark brown and curl up against the stem. Affected leaves may be thick, pointed, produce a bunchy top or "crooks." Lower leaf whorls usually are the most seriously infested. Forced, indoor plants may produce "blind"

buds. *Control:* Dig up and burn infested plants when first found. Plant disease-free, best quality, heat-treated bulbs in clean, well-drained soil. Or soak dormant bulbs before planting in a hot formaldehyde solution (1 tablespoon of 37-40 per cent commercial formaldehyde in 2 quarts of water) at exactly 111° F. for an hour. Then dip in a chloranil solution (5 ounces of wettable Spergon in 3 gallons of water). Dry and plant immediately. Follow a three-year rotation.

12. *Root-lesion (Meadow) and Other Nematodes* (e.g., dagger, lance, spiral, stubby-root, stylet or stunt) — Plants may be stunted. Foliage turns pale or yellow prematurely. Roots stunted and die back. May be bushy, "stubby," or stunted with numerous dead spots. Nematodes are often part of a disease complex with root- and bulb-rotting fungi and mites. *Control:* Rotate. Same as for Leaf and Bud Nematode (above). Plant in clean or sterilized soil (pages 437-44). Root-prune infested roots before treating and planting.
13. *Root-knot* — See (37) Root-knot under General Diseases. *Control:* Same as for Root-lesion Nematode (above).
14. *Damping-off* — Cosmopolitan. See under Beet.
15. *Leaf Spots, Anthracnose* — Spots of various sizes and shapes on the leaves. Spots may drop out, leaving ragged holes. Leaves may wither and die early. Spots may also occur on leaf and flower stalks. Young plants may be stunted. *Control:* Same as for Rusts (above). Rotate.
16. *Frost Injury* — The growing point is killed and plants are stunted by severe frosts. Leaves may be "puffy." *Control:* Cover young shoots or mulch on cold nights when freezing temperatures are expected.

LILY LEEK — See Onion

LILY - OF - THE - VALLEY — See Lily

LIME — See Citrus

LIMONIUM — See Sea - lavender

LINARIA — See Snapdragon

LINDEN [AMERICAN or BASSWOOD, COMMON, COMMON EUROPEAN, CRIMEAN, JAPANESE, LARGE - LEAVED, MANCHURIAN, MONGOLIAN, PYRAMIDAL, SILVER, SMALL - LEAVED EUROPEAN, WEEPING or PENDENT SILVER, WEEPING WHITE (*Tilia*)]

1. *Leaf Blotch or Blight, Anthracnose* — General. Leaves develop small to large, round to irregular, light brown spots with blackish-brown margins. Spots enlarge and form blotches along the veins. Leaves may wither and drop early. Young twigs and branches may die back. *Control:* Prune out and burn dead or cankered twigs. Collect and burn fallen leaves. Fertilize trees to increase vigor. Spray as buds start to swell. Repeat twice more at 10-day intervals. Use fixed copper, zineb, ferbam, captan, or bordeaux mixture (4-4-50).
2. *Twig Blight, Dieback, Trunk and Branch Cankers* — See under Elm and Maple.
3. *Powdery Mildews* — General. Powdery, grayish-white mold on leaves and young shoots. If severe, leaves may turn yellow and wither. *Control:* Where serious enough, spray twice, 10 days apart, using sulfur or Karathane. Start when mildew is first evident.
4. *Leaf Scorch* — Margins of leaves turn brown in midsummer following hot, dry, windy weather. *Control:* Water during summer dry periods. Fertilize and prune out trees to increase vigor.

5. *Leaf Spots, Spot Anthracnose* — Generally small spots on the leaves. Of various colors and shapes. Spots may drop out leaving shot-holes. *Control:* Same as for Leaf Blotch (above).
6. *Wood Rots* — Cosmopolitan. See under Birch, and (23) Wood Rot under General Diseases.
7. *Sooty Mold* — Black, sooty mold patches on leaves. Mold grows on "honeydew" secreted by aphids, scales, and other insects. See Figure 26 under General Diseases. *Control:* Control insects with malathion sprays.
8. *Slime Flux, Wetwood* — See under Elm.
9. *Verticillium Wilt* — See under Maple and Elm. Streaks in the sapwood are dark gray.
10. *Root Rot* — See under Apple, and (34) Root Rot under General Diseases.
11. *Sunscald, Winter Injury* — Common on newly planted trees with thin bark. See under Elm and Apple.
12. *Bleeding Canker* — Northeastern states. See under Beech and Maple.
13. *Mistletoe* — See (39) Mistletoe under General Diseases.
14. *Seed Rot, Damping-off* — See under Pine.

LINDERA — See **Avocado**

LINGONBERRY — See **Blueberry**

LINNAEA — See **Twinflower**

LINUM — See **Flax**

LIONS - EAR or LIONS - TAIL — See **Salvia**

LIPPIA — See **Lantana**

LIQUIDAMBAR — See **Witch - hazel**

LIRIODENDRON — See **Magnolia**

LITHOCARPUS — See **Oak**

LITHOSPERMUM — See **Mertensia**

LITSEA — See **Avocado**

LIVEFOREVER — See **Sedum**

LIVERLEAF — See **Anemone**

LOBELIA, CARDINALFLOWER, INDIAN - TOBACCO (*Lobelia*)

1. *Root Rots, Stem and Crown Rot, Damping-off* — Lower leaves turn yellow. The crown and lower part of the stem decay. The tops wilt and die, or may be stunted. Seedlings wilt and collapse. *Control:* Avoid overwatering, overcrowding, and planting in poorly drained soil. Take cuttings only from healthy plants. Root cuttings in a sterile medium (pages 437-44). Drench crown and surrounding soil with a 1:1,000 solution of mercuric chloride when plants are young.
2. *Mosaic* — Leaves blotched and mottled pale and dark green (certain varieties). Young leaves are distorted and twisted. Older ones are somewhat malformed and brittle. *Control:* Plant healthy stock. Keep down weeds. Destroy the first infected plants. By using lindane or malathion, control aphids which transmit the virus.

3. *Leaf Spots* — Round to irregular, pale tan to reddish-brown spots on the leaves. Leaves may wither and drop early. *Control*: Pick off and burn spotted leaves as they appear. Spray with zineb or maneb during wet periods.
4. *Leaf Smut* — See (13) White Smut under General Diseases.
5. *Gray-mold Blight* — See under Chrysanthemum, and (5) Botrytis Blight under General Diseases.
6. *Rust* — See under Chrysanthemum, and (8) Rust under General Diseases.
7. *Root-knot and Other Nematodes* — See (37) Root-knot under General Diseases. *Lobelia* is very susceptible.
8. *Curly-top* — Shoots have rosettes. Flowers are reduced in size. See (19) Curly-top under General Diseases.
9. *Spotted Wilt* — See under Bellflower, and (17) Spotted Wilt under General Diseases.

LOBLOLLY - BAY — See Franklin - tree

LOBULARIA — See Cabbage

LOCUST — See Honeylocust

LOGANBERRY — See Raspberry

LOLIUM — See Lawnglass

LONICERA — See Snowberry

LOOSESTRIFE — See Lythrum and Primrose

LOQUAT — See Apple

LOTUS — See Waterlily

LOVE - LIES - BLEEDING — See Cockscomb

LUFFA — See Cucumber

LUNARIA — See Cabbage

LUPINE (*Lupinus*) — See Pea

LYCASTE — See Orchids

LYCHNIS — See Carnation

LYCIUM — See Matrimony - vine

LYCOPERSICON — See Tomato

LYCORIS — See Daffodil

LYONIA — See Blueberry

LYSIMACHIA — See Primrose

**LYTHRUM, PURPLE and WINGED LOOSESTRIFE (*Lythrum*); MADEIRA - VINE,
CLIMBING MIGNONETTE (*Boussingaultia*)**

1. *Leaf Spots* — See (1) Fungus Leaf Spot under General Diseases.
2. *Root Rot* — See under Chrysanthemum, and (34) Root Rot under General Diseases.
3. *Root-knot* — See (37) Root-knot under General Diseases.

MACLURA — See **Osage - orange**

MADEIRA - VINE — See **Lythrum**

MADRONE — See **Blueberry**

MAGIC LILY — See **Daffodil**

MAGNOLIA [**ANISE, FRASER or MOUNTAIN, KOBUS,**
LILY - FLOWEDED, OYAMA, PINK STAR, SAUCER, SOUTHERN or BULLBAY,
STAR, SWEETBAY or LAUREL, UMBRELLA, WHITE - LEAF JAPANESE,
WILSON, YULAN], **CUCUMBERTREE** (*Magnolia*); **TULIPTREE** or
YELLOW - POPLAR (*Liriodendron*); **ANISETREE** (*Illicium*)

1. *Leaf Spots, Tar Spot, Spot Anthracnose* — Widespread but rarely serious. Small spots to large, irregular blotches on the leaves. Of various colors and shapes. Infected leaves may drop early. *Control:* Gather and burn fallen leaves. If practical, spray several times, 10 days apart, starting as the buds break open. Use zineb, maneb, fixed copper, or phenyl mercury following the manufacturer's directions.
2. *Wood or Heart Rots* — Cosmopolitan. Foliage is thin. Upper branches die back. Leaves may appear to have a nutrient deficiency. See under Birch, and (23) Wood Rot under General Diseases. *Control:* See under Birch.
3. *Powdery Mildews* — Widespread. Powdery, grayish-white patches on the leaves and young shoots. If severe, leaves may turn yellow and wither. *Control:* Apply two sulfur or Karathane sprays, 10 days apart.
4. *Twig Blights, Cankers, Dieback* — Tops of trees die back. Sunken, flattened, or discolored cankers form on the twigs, larger limbs, and trunk. The bark over affected areas is often discolored and shows longitudinal cracks. *Control:* Cut out and burn cankered wood on the trunk and larger limbs. Paint with a good tree wound dressing. Keep trees vigorous by fertilizing and watering. Spraying as for Leaf Spots (above) may be beneficial. Varieties differ in susceptibility.
5. *Verticillium Wilt* — Leaves on one or more branches commonly droop, roll inward, and turn yellow. Leaves on other branches or trees may wilt rapidly and turn brown or black. Affected leaves usually drop early. Branches die back; may produce dwarfed, sickly leaves the second season. The outer sapwood in the larger branches and trunk shows a dark discoloration. *Control:* See under Maple.
6. *Sooty Mold, Black Mildew* — Cosmopolitan. Black moldy patches on the leaves. See Figure 26 under General Diseases. *Control:* Spray with malathion to control aphids, scales, and other insects. The addition of a fungicide (see under Leaf Spots above) will also be beneficial.
7. *Leaf Yellowing or Scorch* — Leaves turn yellow and drop during hot, dry periods from midsummer on. *Control:* Water trees during these periods. Fertilize to keep trees vigorous. Keep trees pruned out.
8. *Root-knot* — See (37) Root-knot under General Diseases.
9. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases. May be associated with root-feeding nematodes (e.g., burrowing, dagger, lance, root-knot, root-lesion or meadow, spiral, sting, stubby-root, stylet or stunt, trophy-lenchulus).
10. *Seedling Blight, Cutting Rot* — See under Pine.
11. *Thread Blight* — Southeastern states. See under Walnut.
12. *Felt Fungus* — Gulf states. See under Hackberry.
13. *Algal Leaf Spot, Green Scurf, "Red Rust"* — Far south and where damp. Velvety, reddish-brown to orange, cushiony patches or greenish-brown spots on the leaves. *Control:* Spray with fixed copper during rainy periods. Improve drainage.

MAHONIA — See **Barberry**

MAIDENHAIR - TREE — See **Ginkgo**

MALACOTHRIX — See **Chrysanthemum**

MALANGA — See **Calla**

MALEBERRY — See **Blueberry**

MALLOW — See **Hollyhock**

MALTESE CROSS — See **Carnation**

MALUS — See **Apple**

MALVA, MALVASTRUM — See **Hollyhock**

MAMMILLARIA — See **Cactus**

MANFREDA — See **Centuryplant**

MANGEL, MANGOLD — See **Beet**

MANILAGRASS — See **Lawnglass**

MANZANITA — See **Blueberry**

MAPLE [**AMUR, BIGLEAF, BLACK, COLUMNAR RED, COLUMNAR SUGAR, DRUMMOND, FERNLEAF, GOLDEN MOON, HARLEQUIN, HEDGE or FIELD, JAPANESE, MANCHURIAN, MOUNTAIN, NIKKO, NORWAY (many horticultural varieties), PAPERBARK, OREGON, RED or SCARLET, RED LEAF (CRIMSON KING, SCHWEDLER'S), SILVER or SOFT, STRIPED or MOOSEWOOD, SUGAR or HARD, SYCAMORE, TATARIAN, TRIDENT, VINE], BOXELDER [COMMON, CALIFORNIA] (Acer)**

1. *Anthracnose, Leaf Blights* — General in wet springs on sugar, silver, and Japanese maples and boxelder. Irregular, light to reddish-brown, or purplish-brown, dead areas on the leaves. Many along the veins. Areas often enlarge, killing the leaf. Leaves often appear scorched as if by frost or hot dry weather. Many infected leaves drop in late spring. Twigs may die back. See Figure 17B under General Diseases. *Control:* Collect and burn fallen leaves. Prune out dead twigs and weak wood to increase air circulation and promote faster drying. If practical, apply 3 sprays: the first as buds begin to unfold in the spring and then repeat 10 and 20 days later. Use phenyl mercury, zineb, dichlone, captan, or ferbam plus spreader-sticker. Try to time sprays just before wet periods when infections occur. Fertilize and water to stimulate vigorous growth.
2. *Verticillium Wilt, Maple Wilt* — Widespread and destructive, especially on silver, Norway, and sugar maples. Leaves suddenly discolor and wilt on one or more limbs. Often on one side of the tree or in the crown. Leaves die and fall or hang on dead branches. Later other limbs wilt and die. Olive-green to brown or bluish-black streaks may occur in the sapwood, often at a distance from wilting foliage. Infected trees may die within a few weeks or live on for a number of years. See Figure 30C under General Diseases. *Control:* Cut down and burn severely infected trees. Where only 1 to 6 limbs show wilt, promptly prune off affected parts. Swab tools with 70 per cent denatured alcohol between cuts. Paint wounds promptly with a tree wound dressing (page 25). Fertilize heavily and water trees to stimulate vigor. Maples vary in resistance.
3. *Leaf Scorch* — Light or dark brown areas on the leaf between the veins or along

the margin. Foliage appears bronzed, dried, and scorched. Affected leaves may drop early. Causes: Late spring frost; hot, dry summer winds; and drought (see Figure 1). *Control:* Water trees during summer droughts. Plant in a location protected from drying winter and summer winds and bright, all-day sun (especially sugar, red leaf, and harlequin maples). Fertilize and prune to keep trees growing vigorously. Plant maples recommended for your area.

4. *Chlorosis* — May be caused by several factors, e.g., deficiency of one or more mineral elements (especially iron) or moisture, excessive soil moisture or plant nutrients, high water table, winter injury, gas main leak, or change in the soil level. See under "Environmental Factors" in Section 2.

In *alkaline* soils, iron chlorosis is characterized by a light yellowish color of the leaves between the veins. Leaves may later become dwarfed and ivory-colored. Twigs are stunted and die back. Affected plants are quite susceptible to winter injury. *Control:* Determine cause of chlorosis and correct the condition. Check iron chlorosis by adding iron citrate or sulfate to one or more pest sprays. Trees and shrubs can also be treated by applying a mixture of iron (ferrous) sulfate and sulfur or iron chelate [e.g., Versenol (Dow) or Sequestrene (Geigy)] in a series of holes in one or more rings in the soil under the outer ends of the branches (see page 19 on how to fertilize trees). Three ounces worked into the soil is usually enough for an average-sized shrub. Trees take much more. Follow the fertilizer manufacturer's directions. Such mixing can be done when the plants are fertilized. Check with your nurseryman, county agent, or extension horticulturist on what and how much to use. Gelatin capsules containing iron (ferrous or ferric) citrate, phosphate, or tartrate are available in some areas. These can be inserted into $\frac{3}{8}$ inch diameter holes drilled in the base of the trunk. On larger trees the holes are usually drilled $1\frac{1}{2}$ inches deep and about 3 inches apart. This should be done by a competent arborist since the holes should be drilled correctly and then sealed with cork stoppers. Finally the wounds are painted with tree paint or grafting wax to seal out moisture and wood rot organisms. Iron chelates may also be injected into trees. Treatment is usually undertaken a few weeks before growth starts in the spring.

5. *Twig Blights, Cankers, Dieback* — Sunken or flattened, discolored cankers appear on the twigs, branches, and even the trunk. Twigs and small branches die back. Entire trees may die. Affected bark is often sprinkled with small "pimples" which may erupt and show black, reddish-brown or coral-red, cushion-shaped bodies. A thick callus sometimes with concentric rings may accompany the canker. Wood beneath the cankered bark is discolored. *Control:* Avoid wounding the bark. Make flush pruning cuts (see Figure 9). Cover promptly with a tree wound dressing (page 25). Water and fertilize to stimulate vigor. Prune out cankers several inches below diseased areas and paint over cuts with tree wound dressing. Extensive trunk cankers cannot be surgically removed.
6. *Bleeding Canker* — Northeastern states. Infects Norway, red, sycamore, and sugar maples. Reddish-brown cankers form in the inner bark of the trunk and larger branches. The bark becomes sunken and furrowed over the cankers. Light brown to reddish-brown fluid ("blood") oozes out through openings in the outer bark. Foliage is often sparse, dwarfed, and yellowish-green. Leaves may wilt and branches die back. *Control:* See under Beech.
7. *Branch and Trunk Cankers* — Foliage is thin, dwarfed, and sickly. Branches or entire trees die back from girdling cankers. Roots may decay. *Control:* See under Apple and Beech. Plant in well-drained, rich soil. Avoid bark injuries.
8. *Wood Rots* — Cosmopolitan. See under Birch, and (23) Wood Rot under General Diseases. Maples are quite susceptible.

9. *Leaf Spots, Tar Spot* — General. Round to irregular, light to reddish-brown, gray, yellowish-gray, or shiny, black spots on the leaves. Some leaves may wither and drop early. Seldom serious. *Control:* If practical, same as for Anthracnose (above).
10. *Root Rots* — General. Trees decline in vigor. Foliage is thin and sickly. Leaves may turn yellow, wither, and fall early. Trees tend to die back. See under Apple, and (34) Root Rot under General Diseases. May be associated with root-feeding nematodes (e.g., dagger, lance, pin, ring, root-knot, root-lesion or meadow, sheath, spear, spiral, stem, stubby-root, stylet or stunt).
11. *Crown Gall* — Rough, irregular, swollen galls at the base of the trunk or on the roots. Trees lack vigor. Make poor growth. Leaves may turn yellow. *Control:* See under Apple, and (30) Crown Gall under General Diseases.
12. *Leaf Blisters* — Round to irregular leaf "blisters" which are an ochre-buff to dark brown above and a pinkish-buff underneath. Leaves may roll and curl inward, drop early. Minor pest. Sugar and black maples are most susceptible. *Control:* If disease has been prevalent in past years, apply a single dormant spray. See under Peach, and (10) Leaf Curl under General Diseases.
13. *Slime Flux, Wetwood* — See under Elm.
14. *Sooty Mold, Black Mildew* — Black mold growth on leaves. *Control:* Spray with a mixture of DDT and malathion to control insects (e.g., aphids and scales) which secrete honeydew in which the sooty mold fungi grow.
15. *Sunscald, Winter Injury* — Maples are very susceptible. See under Elm and Apple.
16. *Powdery Mildews* — Minor pest. See under Birch.
17. *Mistletoe* — See (39) Mistletoe under General Diseases.
18. *2,4-D Injury* — Boxelder is very susceptible. See under Grape.
19. *Thread Blight* — Southeastern states. See under Walnut.
20. *Felt Fungus* — Southern states. See under Hackberry.
21. *Seedling Blight* — See under Pine.

MARANTA — See Rabbit Tracks

MARBLESEED — See Mertensia

MARGUERITE, MARIGOLD — See Chrysanthemum

MARINE - IVY — See Grape

MARIPOSA LILY, GLOBE-TULIP, GLOBE LILY (*Calochortus*)

1. *Rust* — Western half of the United States. Yellow to dark, powdery pustules on the foliage. *Control:* Cut and burn infected foliage after plants bloom. Apply zineb, ferbam, or maneb at 10- to 14-day intervals.

MARJORANA, MARRUBIUM — See Salvia

MATRICARIA — See Chrysanthemum

MATRIMONY - VINE, CHINESE WOLFBERRY (*Lycium*)

1. *Powdery Mildews* — Powdery, white mold patches on the leaves in summer and fall. *Control:* Spray or dust 2 or 3 times, starting when mildew first appears. Use sulfur, Karathane, or Acti-dione at 10-day intervals. Follow the manufacturer's directions.
2. *Leaf Spots* — More or less round, tan, gray, or brown spots on the leaves in rainy

seasons. *Control:* Pick off and burn infected leaves. If serious enough, spray several times, 10 days apart, using zineb or maneb.

3. *Rusts* — Reddish-brown, then black, powdery pustules on the leaves. *Control:* Not usually necessary. Same as for Leaf Spots (above).

4. *Mosaic* — See (16) Mosaic under General Diseases.

MATTHIOLA — See Cabbage

MAURANDYA — See Snapdragon

MAYAPPLE (*Podophyllum*)

1. *Rust* — General and destructive. Large areas of the new leaves in the spring turn yellowish in spots and later a chocolate-brown in color. Leaves wither and die early. *Control:* Completely dig up and destroy infected plants.

2. *Leaf Spots, Leaf Blight* — Widespread in rainy seasons. Spots of various colors, sizes, and shapes develop on the leaves, especially in shady spots. *Control:* Pick off and burn spotted leaves. Where practical, apply several sprays, at about 10-day intervals, using zineb, maneb, or fixed copper.

3. *Stem Rot* — Base of stem may rot causing the foliage to wilt, wither, and die. *Control:* Plant in well-drained soil. Avoid overwatering and heavy shade. Dusting or drenching the soil with Terraclor (PCNB) may be beneficial if applied early enough. Follow the manufacturer's directions.

4. *Gray-mold Blight* — See (5) Botrytis Blight under General Diseases. *Control:* Same as for Leaf Spots (above).

MAYDAY - TREE — See Peach

MAYFLOWER — See Heath

MEADOWBEAUTY — See Deergrass

MEADOWRUE — See Delphinium

MEADOWSWEET — See Rose and Salvia

MECONOPSIS — See Poppy

MEDLAR — See Apple

MELIA — See Chinaberry

MELISSA — See Salvia

MENISPERMUM — See Moonseed

MENTHA — See Salvia

MENTZELIA, BLAZING - STAR, PRAIRIE LILY (*Mentzelia*)

1. *Leaf Spots* — Small spots on the leaves, usually with a distinctive border. Centers of older spots are sprinkled with black dots. *Control:* Pick off and destroy infected leaves. If practical, spray during wet periods using zineb, maneb, or fixed copper.

2. *Rusts* — Small yellow to orange spots on the leaves. Alternate hosts: wild grasses or none. *Control:* Same as for Leaf Spots.

3. *Root and Stem Rots* — Plants stunted and sickly. May wilt and collapse from rotting at the soil line and below. *Control:* Avoid overwatering and planting in heavy, poorly drained soil. Drench or dust the soil with Terraclor before planting. Follow the manufacturer's directions.

MENZIESIA — See Blueberry**MERRYBELLS — See Lily**

**MERTENSIA, BLUEBELLS, VIRGINIA COWSLIP (*Mertensia*);
ALKANET, BUGLOSS, AFRICAN FORGET - ME - NOT (*Anchusa*);
BORAGE (*Borago*); HOUNDSTONGUE, CHINESE FORGET - ME - NOT
(*Cynoglossum*); HELIOTROPE (*Heliotropium*); PUCCOON,
GROMWELL (*Lithospermum*); FORGET - ME - NOT (*Myosotis*);
MARBLESEED (*Onosmodium*)**

1. *Gray-mold Blight, Botrytis Blight* (forget-me-not, heliotrope, mertensia) — Cosmopolitan. Especially under cool, moist conditions. Base of stem turns brown, rots, and plant may collapse in damp weather. Flowers, leaves, buds, and shoot tips may also be blighted. Affected parts may be covered with a coarse gray mold. *Control:* Carefully collect and burn infected plant parts. Space plants. Keep down weeds. Spray at 5- to 10-day intervals during cool, moist weather. Use captan, zineb, maneb, or fixed copper.
2. *Stem Rots, Crown Rot, Southern Blight, Wilt, Damping-off* — Plants wilt and later turn brown from rot at the soil line. Affected area may be covered with a dense cottony mold. Seedlings wilt and collapse. *Control:* Remove and destroy infected plants together with 6 inches of surrounding soil. Avoid overwatering. Rotate. See also under *Delphinium*.
3. *Downy Mildew* (forget-me-not, houndstongue, mertensia) — Pale spots or yellowish blotches on the upper leaf surface with a delicate, grayish-white mold developing on the corresponding underleaf surface in humid weather. *Control:* Spray at 5- to 10-day intervals during cool, rainy weather, using zineb, maneb, or fixed copper.
4. *Aster Yellows, Curly-top* (*anchusa*, forget-me-not) — See (18) *Yellows*, and (19) *Curly-top* under General Diseases.
5. *Powdery Mildew* (*anchusa*, *houndstongue*, *lithospermum*, *mertensia*) — White, powdery blotches on the stems and leaves. Leaves may turn yellow and wither. *Control:* Space plants. Increase air circulation. Dust or spray with sulfur or Karathane.
6. *Leaf Spots* — See under *Chrysanthemum*, and (1) *Fungus Leaf Spot* under General Diseases.
7. *Leaf Smut* (*mertensia*) — Round, pale spots or "blisters" on the leaves which are later filled with black powdery masses. *Control:* See (13) *White Smut* under General Diseases.
8. *Root-knot* — See (37) *Root-knot* under General Diseases.
9. *Rusts* (*anchusa*, forget-me-not, heliotrope, *lithospermum*, *marbleseed*, *mertensia*) — See (8) *Rust* under General Diseases. Alternate hosts include wild grasses and rye.
10. *Black Ringspot* (forget-me-not) — See under *Cabbage*.
11. *Mosaic* (*anchusa*, *mertensia*) — Widespread. Mottled, yellowish-green and dark green leaves. Plants may be stunted. *Control:* Dig up and burn infected plants. Keep down weeds. Spray with malathion or lindane to control aphids.
12. *Root Rot* — See under *Geranium*, and (34) *Root Rot* under General Diseases.
13. *Verticillium Wilt* (heliotrope) — Leaves and flowers turn black, wilt, and shrivel. Brown streaks develop inside stems and appear when stem is cut. *Control:* See (15B) *Verticillium Wilt* under General Diseases.
14. *Leaf Scorch* (heliotrope) — Margins of leaves turn dark brown during hot, dry weather. *Control:* Plant in partial shade in a protected location. Lower the temperature, if possible.

MESCALBEAN — See **Honeylocust**

MESEMBRYANTHEMUM — See **Iceplant**

MESPILUS — See **Apple**

MEXICAN FIRE - PLANT — See **Poinsettia**

MEZEREUM — See **Daphne**

MICHAELMAS DAISY — See **Chrysanthemum**

MICROMERIA — See **Salvia**

MIGNONETTE (Reseda)

1. *Leaf Spot, Blight* — Widespread in the eastern half of the United States. Numerous small, pale tan to yellowish-brown spots with reddish-brown borders, mostly on the lower leaves. Spots enlarge and quickly run together in wet weather. Entire leaves become blighted, reddish, and die. Stalks and seedpods may also be infected. *Control:* Plant disease-free seed. Spray weekly in rainy weather using zineb, maneb, or fixed copper.
2. *Root Rot, Damping-off* — Seedlings wilt and collapse. Older plants are stunted and sickly with yellowish leaves. Base of stem and roots decay. *Control:* Destroy infected plants. Rotate. Avoid overwatering and planting in poorly drained soil. Where practical, replant in sterilized soil (pages 437-44).
3. *Downy Mildew* — Pale spots on the upper leaf surface with a delicate whitish mold growing from the corresponding undersurface in moist weather. *Control:* Same as for Leaf Spot (above).
4. *Root-knot* — See (37) Root-knot under General Diseases.
5. *Verticillium Wilt* — See (15B) Verticillium Wilt under General Diseases.
6. *Black Ringspot* — See under Cabbage.
7. *Yellows* — See (18) Yellows under General Diseases.

MILTONIA — See **Orchids**

MIMOSA — See **Pea**

"MIMOSA" TREE — See **Honeylocust**

MIMULUS — See **Snapdragon**

MINNIE - BUSH — See **Blueberry**

MINT — See **Salvia**

MIRABILIS — See **Four - o'clock**

MISSOURI PRIMROSE — See **Evening - primrose**

MISTFLOWER — See **Chrysanthemum**

MITCHELLA — See **Buttonbush**

MITREWORT (Mitella) — See **Hydrangea**

MOCK - CUCUMBER — See **Cucumber**

MOCKORANGE — See **Hydrangea**

MOCK - STRAWBERRY — See **Rose**

MOLUCELLA — See **Salvia**

MOMORDICA — See **Cucumber**

MONARDA, MONARDELLA — See **Salvia**

MONEYWORT — See **Primrose**

MONKEYFLOWER — See **Snapdragon**

MONKEYPUZZLE TREE — See **Araucaria**

MONKSHOOD — See **Delphinium**

MONKSHOOD - VINE — See **Grape**

MONSTERA — See **Calla**

MONTBRETIA — See **Gladiolus**

MOONFLOWER — See **Morning - glory**

MOONSEED (*Menispermum*); CAROLINA MOONSEED (*Cocculus*)

1. *Leaf Spots* — Widespread. Spots of various colors, sizes, and shapes on the leaves. Similar spots may also occur on the stems. *Control:* Pick off and burn spotted leaves. If severe, spray several times during rainy periods, at 7- to 10-day intervals. Use zineb, manebe, or captan.
2. *Powdery Mildew* (*menispermum*) — Widespread. Grayish-white, powdery mold growth on the foliage. *Control:* If serious enough, spray two or three times, 10 days apart, with sulfur or Karathane.
3. *Leaf Smut* (*menispermum*) — See (13) *White Smut* under General Diseases.
4. *Root Rot* — See (34) *Root Rot* under General Diseases.
5. *Burrowing Nematode* — Florida. Associated with sickly, declining Carolina moonseed plants. *Control:* Set disease-free plants in sterilized soil.

MORNING - GLORY [BUSH, COMMON, IVYLEAF, WHITE - EDGE], HEARTS AND HONEY VINE, GIANT NIGHT WHITE BLOOMER (*Ipomoea*); ARGYREIA; MOONFLOWER (*Calonyction*); CALIFORNIA - ROSE, BUSH MORNING - GLORY, BINDWEED (*Convolvulus*); JACQUEMONTIA; CYPRESSVINE, STARGLORY, CARDINAL CLIMBER (*Quamoclit*)

1. *Leaf Spots* — Spots of various colors and sizes on leaves, often with a distinct margin. *Control:* Pick off and burn spotted leaves. Cut and burn tops in the fall. If serious enough, spray as for Rusts (below).
2. *Rusts* — Primarily in the southern states. Unimportant in gardens. Yellowish spots on the upper leaf surface and reddish-brown, powdery pustules on the underleaf surface. Alternate hosts include pines. *Control:* Apply ferbam, fixed copper, or zineb several times, 10 days apart.
3. *White-rust* — Widespread. Serious sometimes in the southern states. See under Cabbage, and (9) *White-rust* under General Diseases.
4. *Stem Rot, Stem Canker, Damping-off* — Sunken brown areas on the stem or soft rotting of the crown which may be covered with a cottony mold. Seedlings wilt and collapse. *Control:* Destroy infected plants. Plant in clean, well-drained soil. Avoid overwatering.

5. *Root Rot* — See (34) Root Rot under General Diseases. May be associated with root-feeding nematodes (e.g., reniform, sting).
6. *Root-knot* — See (37) Root-knot under General Diseases.
7. *Leaf Nematode* (moonflower) — Brown blotches on the leaves, bounded by the veins. Leaves may shrivel, die, and hang on the plant. Variegated moonflower varieties are considered more susceptible. *Control:* See under Chrysanthemum, and (20) Leaf Nematode under General Diseases.
8. *Mosaic* — Yellowish-white and greenish mottling of the leaves. See (16) Mosaic under General Diseases.
9. *Curly-top* — Western states. See (19) Curly-top under General Diseases.
10. *Fusarium Wilt* (morning-glory) — See (15A) Fusarium Wilt under General Diseases.
11. *Blossom Blight* — See (31) Flower Blight under General Diseases.
12. *Thread Blight* (jacquemontia, morning-glory) — Southeastern states. See under Walnut. *Control:* Spray as for Leaf Spots (above).

MORUS — See Mulberry

MOSES - IN - A - BOAT — See Rhoea

MOSQUITO BILLS— See Primrose

MOSS - PINK — See Phlox

MOTHER - OF - THYME — See Salvia

MOUNDLILY— See Yucca

MOUNTAIN - ASH — See Apple

MOUNTAIN - BLUET — See Chrysanthemum

MOUNTAIN CRANBERRY — See Blueberry

MOUNTAIN - HOLLY — See Holly

MOUNTAIN - LAUREL — See Blueberry

MOUNTAIN - MINT — See Salvia

MOUNTAIN-SPICEWOOD — See Calycanthus

MOUNTAIN SPURGE — See Pachysandra

MUGWORT — See Chrysanthemum

MULBERRY [RED, RUSSIAN, WEEPING, WHITE or CHINESE] (*Morus*)

1. *Twig Blights, Cankers, Dieback* — Widespread. Small to long, sunken cankers on the twigs and branches. Branches die back and trees may gradually die over a period of years. Small, coral-pink to black "pimples" may be evident in the bark. *Control:* Prune out and burn all twigs and branches showing cankers. Keep trees growing vigorously by fertilizing and watering. Varieties differ in resistance.
2. *Bacterial Spot, Blight* — General. Small, angular, water-soaked spots on the leaves and shoots which turn brown to black and become sunken. Young leaves may be distorted and turn yellow to brown. Elongated black spots or stripes on the shoots. Twigs may be blighted. Trees may be stunted. *Control:* Prune out and burn blighted twigs in late fall. If practical, apply a copper fungicide before rainy periods. Avoid overhead sprinkling in the nursery.

3. *Fungus Leaf Spots* — Common in rainy seasons, but cause little damage. Spots of various colors, sizes, and shapes on the leaves. Some leaves may drop early. *Control:* Collect and burn fallen leaves. If practical, spray several times, 10 days apart, using zineb, maneb, or fixed copper.
4. *Powdery Mildews* — Powdery, white blotches on the underleaf surface. *Control:* Spray two or three times, 10 days apart, using sulfur or Karathane.
5. *Wood and Heart Rots* — See (28) Wood Rot under General Diseases.
6. *False Mildew* — Southern states. Indefinite, whitish, cobwebby blotches on the underleaf surface in midsummer. Yellowish areas later develop on the upper side. Leaves may wither and fall early. Most serious in shady areas. *Control:* Same as for Fungus Leaf Spots (above).
7. *Root-knot* — Mulberry is very susceptible. See under Peach, and (37) Root-knot under General Diseases.
8. "Popcorn" (*Berry-hardening*) Disease — Minor disease in southern states. Carpels of fruit are small and remain green, interfering with normal ripening. *Control:* None necessary.
9. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases.
10. *Hairy Root* — See under Apple.
11. *Rust* — Southern states. Unimportant. Brownish pustules on the lower leaf surface. *Control:* Same as for Fungus Leaf Spots (above).
12. *Wetwood, Slime Flux* — See under Elm.

MULLEIN-PINK — See Carnation

MUSCARI — See Tulip

MUSKMELON — See Cucumber

MUSTARD — See Cabbage

MYOSOTIS — See Mertensia

MYRICA — See Waxmyrtle

MYRTLE (*Myrtus*); FEIJOA; GUAVA (*Psidium*)

1. *Powdery Mildew* (myrtle) — Southern states. Grayish-white, powdery growth on the leaves. Most common in crowded, shaded areas. *Control:* Spray two or three times, 10 days apart, with Karathane.
2. *Leaf Spot* — Small spots or blotches on the leaves. *Control:* Pick off and burn spotted leaves.
3. *Stem or Crown Rot* (myrtle) — Plants wilt and die from rot at the soil line. *Control:* Avoid overwatering, overcrowding, and planting in poorly drained soil. See under Delphinium.
4. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases. Declining, sickly plants may be associated with root-feeding nematodes (e.g., burrowing, dagger).
5. *Anthracnose, Spot Anthracnose or Scab, Leaf and Fruit Spots, Fruit Rots* (feijoa, guava) — Leaves and fruits are variously spotted and rotted. Ripe fruits may rot and be covered with a gray, brown, black, bluish-green, or pink mold. *Control:* Spray during rainy periods using captan or zineb.
6. *Root-knot* — See (37) Root-knot under General Diseases.

7. *Wood Rots* — Attacks guava. See (23) Wood Rot under General Diseases.
8. *Thread Blight* (feijoa, guava) — Southeastern states. See under Walnut.

MYRTLE BOXLEAF — See Bittersweet**NANDINA, HEAVENLY BAMBOO (*Nandina*)**

1. *Leaf Spot, Anthracnose* — Southern states. Leaves are spotted. Centers of red spots may later turn almost black. *Control:* Pick off and burn spotted leaves. If serious enough, spray several times, 10 days apart, using zineb, maneb, or fixed copper.
2. *Root-knot* — Plants may be sickly and stunted with nodule-like galls on the roots. See (37) Root-knot under General Diseases.
3. *Root Rot* — See (34) Root Rot under General Diseases. May be associated with nematodes (e.g., dagger, lance, root-knot, spiral).
4. *Chlorosis* — Foliage turns yellow in alkaline soils. Plants may be stunted. See under Maple.

NANNYBERRY — See Viburnum**NARCISSUS — See Daffodil****NASTURTIUM (Watercress) — See Cabbage****NASTURTIUM, GARDEN; CANARYBIRDFLOWER (*Tropaeolum*)**

1. *Bacterial Wilt* — Mostly southern states. Plants may turn yellow, wilt, and die before blossoming. Stems near the soil line often appear water-soaked. Black streaks appear when the stem is cut through. Roots decay and turn black. *Control:* Remove and burn infected plants. Plant in clean soil which has not grown wilted potato, tomato, eggplant, tobacco, or other plants. Rotate plantings.
2. *Fungus Leaf Spots* — Spots of various sizes, shapes, and colors on the leaves. Leaves may wither and drop early. *Heterosporium* spot may also cause rotting of the stems. It is severe in California along the coast. *Control:* If serious enough, apply zineb, maneb, or fixed copper at about weekly intervals during rainy weather. Commercial seedsmen control *Heterosporium*, which is seed-borne, by soaking the seed in hot water (page 429). Presoak seed 1 hour in cool tap water.
3. *Bacterial Leaf Spot* — Small, water-soaked, brownish spots on the leaves. Leaves may later rot. *Control:* Pick off and burn spotted leaves. Spraying as for Fungus Leaf Spots (above) may be beneficial.
4. *Mosaics* — Symptoms highly variable. Yellow spotting and mottling of the leaves. Young leaves may be ruffled and cupped. Large, yellow to brown, arrow-shaped blotches or white, dead ringspots may also be found on the leaves. Flowers show a distinctive color break. May be small and crinkled. *Control:* Destroy infected plants when first found. Keep down weeds. Spray or dust weekly with a mixture of malathion and DDT to control aphids which transmit the viruses.
5. *Spotted Wilt* — Numerous, yellowish to brown or dead spots and blotches develop on the leaves. Leaves are distorted, cupped, stunted, and may show a yellowish mottling. Plants are usually stunted. *Control:* Same as for Mosaics (above). The virus is spread by thrips.
6. *Ringspot* — Leaves mottled light and dark green with yellowish-green and yellow ring and line patterns or yellowish spots bordering the veins. Leaves may be crinkled, stunted, and partly dead. Plants may apparently recover and appear normal. *Control:* Same as for Mosaics (above).

7. *Curly-top* — Older leaves are usually yellow. Numerous shoots are produced with dwarfed, cupped leaves. Flower parts of immature flowers are withered and dry. Flower buds are usually dwarfed and yellow. May fail to open. *Control:* Same as for Mosaics (above).
8. *Aster Yellows* — Plants stunted, yellow, and bushy. *Control:* Same as for Mosaics (above). The virus is spread by leafhoppers.
9. *Root-knot, Root Gall* — Small knots or galls on the roots. Plants may appear stunted and sickly. *Control:* See (37) Root-knot under General Diseases.
10. *Fasciation* — See (28) Leafy Gall under General Diseases.
11. *Rust* — Utah. Small, yellowish pustules on the leaves. Alternate hosts are wild grasses (*Aristida* and *Distichlis*). *Control:* Same as for Fungus Leaf Spots (above).

NATAL-PLUM — See Oleander

NECTARINE — See Peach

NELUMBO — See Waterlily

NEMOPANTHUS — See Holly

NEMOPHILA — See Phacelia

NEPETA — See Salvia

NEPHROLEPIS — See Ferns

NEPHTHYTIS — See Calla

NERINE — See Daffodil

NERIUM — See Oleander

NEW GUINEA BEAN — See Cucumber

NEW JERSEY-TEA, JERSEY-TEA, DELISLE CEANOOTHUS (*Ceanothus*)

1. *Leaf Spots* — Common. Small, more or less round spots on the leaves. *Control:* Not usually necessary. If serious enough, spray during rainy periods using zineb or maneb.
2. *Powdery Mildew* — Widespread in late summer and fall. Powdery, white mold patches on the leaves. *Control:* Apply sulfur or Karathane weekly, starting when mildew first appears.
3. *Rust* — Small, yellowish spots on the leaves. Alternate hosts are wild grasses. *Control:* Same as for Leaf Spots (above).
4. *Crown Gall* — See under Apple, and (30) Crown Gall under General Diseases.
5. *Wood Rot* — See under Birch, and (23) Wood Rot under General Diseases.
6. *Root Rot* — See under Apple, and (34) Root Rot under General Diseases.
7. *Dieback, Canker* — See under Apple and Maple.

NEW ZEALAND SPINACH — See Beet

NICANDRA, NICOTIANA, NIEREMBERGIA, NIGHTSHADE — See Tomato

NINEBARK [COMMON, ILLINOIS] (*Physocarpus*)

1. *Leaf Spots* — Not serious. See under Maple.
2. *Powdery Mildew* — Not serious. See under Birch.
3. *Wood Rot* — See under Birch.
4. *Root Rot* — See (34) Root Rot under General Diseases.
5. *Fire Blight* — See under Apple.

NORFOLK ISLAND PINE — See Araucaria

NOTHOSCORDUM — See Onion

NUPHAR, NYMPHAEA — See Waterlily

NYSSA — See Dogwood

OAK [BLACK, BLACKJACK, BUR, CHESTNUT (CHINESE, SWAMP or BASKET, CHINQUAPIN and DWARF CHINQUAPIN), COLUMNAR ENGLISH, CORK, ENGLISH, HOLM or HOLLY, LAUREL, LIVE (CALIFORNIA, CANYON, INTERIOR, SOUTHERN), PIN and NORTHERN PIN, POST, OVERCUP, RED, SCARLET, SHINGLE, SHUMARD, TEXAS, TURKEY, WATER, WHITE (OREGON, ROCKY MOUNTAIN, SWAMP, VALLEY), and WILLOW] (Quercus); TANBARK-OAK (*Lithocarpus*)

1. *Oak Wilt* — Serious over much of the eastern half of the United States. All oaks are susceptible. Chinese and American chestnuts, tanbark-oak, and chinquapin may also be infected. Uncommon on planted specimen trees. Leaves may turn a pale or dull green or be water-soaked, curl, progressively become more yellowed or bronzed from the tips and margins inward. Leaves on the upper branches are usually affected and drop first. Red and black oaks die in a few weeks. Individual white or bur oaks die back slowly (becoming stag-headed) over a period of several years or longer. Dark streaks can often be seen in the wood just under the bark of wilting branches. See Figure 142. The causal fungus may spread to nearby trees by underground root grafts or insects. *Control:* Remove and burn all infected and dead oaks as soon as possible. If other oaks are nearby on the property, dig a trench 4 feet deep, or poison all oaks with brush-killer (50:50 mixture of 2,4-D and 2,4,5-T in fuel oil) or Ammate in a 50-foot circle from an infected tree. Do not injure or prune trees from April through June. If wounds are made, paint them promptly with a tree wound dressing (page 25). Check with your nurseryman, county agent, or extension plant pathologist. *Infected trees cannot be cured.*
2. *Anthracnose, Leaf and Twig Blight* — White oak is very susceptible. Most serious on the bottom half of trees in shaded areas during moist spring weather. Leaves turn brown and curl from the margins giving a scorched appearance. Small to large, irregular, light brown spots occur on black and red oak leaves. The spots often enlarge along the veins. Weakened trees may die if leaves drop early. See Figure 143. *Control:* Same as for Sycamore Anthracnose. Apply phenyl mercury as the buds are swelling in early spring.
3. *Leaf Blister, Leaf Curl (oaks)* — General in cool, wet springs. Yellowish-green to gray, reddish, purple, yellow or brown, more or less round, raised blisters on the upper leaf surface (Figure 144). Trees may appear scorched. Affected leaves may pucker or curl and drop in large numbers, weakening affected trees. *Control:* If practical, spray 1 to 2 weeks before the buds swell, using zineb, maneb, ferbam, dichlone, captan, or fixed copper. Collect and burn fallen leaves.
4. *Leaf Spots, Spot Anthracnose* — Numerous spots of various sizes, shapes, and colors develop on the leaves in wet seasons. If severe, some leaves may wither and drop early. *Control:* Same as for Anthracnose (above).
5. *Wood Rots, Heart Rots, Butt Rot* — Cosmopolitan. See under Birch, and (23) Wood Rot under General Diseases.
6. *Twig Blights, Dieback* — Cosmopolitan. Leaves scattered over the tree suddenly blight, curl, and hang downward. Twigs and small branches die back from sunken, girdling cankers. *Control:* See under Maple.

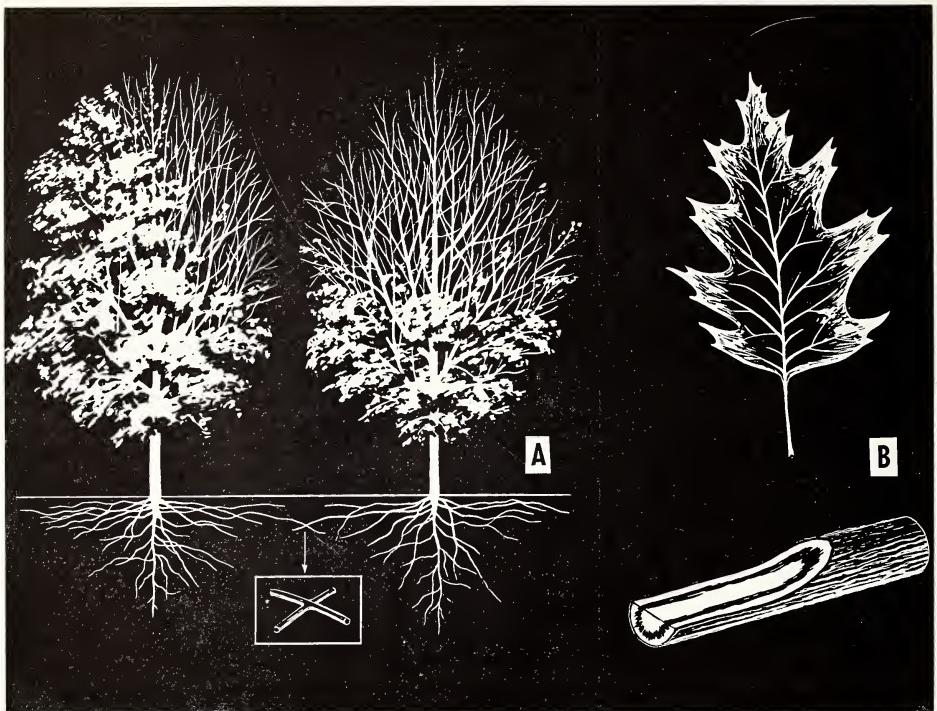


Fig. 142. Oak wilt. A. Gross symptoms of red or black oaks (insert shows grafting of roots), B. Red oak leaf and twig symptoms.



Fig. 142C. "Stag-head" of white oak. (Iowa State University photo)



Fig. 143. Oak anthracnose.



Fig. 144. Oak leaf blister or leaf curl.
(Courtesy Dr. V. H. Young)

7. *Branch and Trunk Cankers* — Widespread. Discolored, enlarging, flattened or sunken cankers on the branches or trunk. Small trees may be killed. See under Elm.
8. *Root Rots* — Cosmopolitan. Trees lack vigor, decline. Foliage is thin and sickly. Leaves may turn yellow, wither, and drop early. Stag-headed, dead branches are common. Trunk may break over during high winds. Roots and the base of the trunk are partially or completely rotted. Coarse strands of white mold growing just under the bark are common. Clumps of toadstools may appear near the trunk base. *Control:* See under Apple, and (34) Root Rot under General Diseases.
9. *Crown Gall* — See under Apple, and (30) Crown Gall under General Diseases.
10. *Leaf Rusts* — Minor problem. Small yellowish spots on the underleaf surface. Later, brown pustules develop. Alternate hosts include 2- and 3-needle pines. *Control:* None needed.
11. *Chlorosis, Iron Deficiency* — See under Maple. Pin and willow oaks are very susceptible in neutral and alkaline soils. Twig growth is stunted. May die back.
12. *Powdery Mildews* (oak) — General. May cause injury in southern and western states. White to brown, powdery mold on undersides of leaves, new shoots, and buds. Leaves may be stunted, yellowish, wither, and drop early. Twigs may be stunted. Produce witches'-brooms of live oak in California. Oaks vary greatly in susceptibility. *Control:* If practical, spray when mildew is first evident. Use sulfur or Karathane. Prune out witches'-brooms on live oak along the Pacific Coast. Apply a dormant spray of lime-sulfur (1 to 50 dilution).
13. *Leaf Scorch* — Browning or scorching of leaves between the veins or along the margins following hot, dry, windy weather in July and August. *Control:* Water during summer dry periods. Prune and fertilize to increase vigor.
14. *Sooty Mold, Black Mildew* — Primarily southern states. Purplish-black mold patches

on the foliage. Often follows insect attacks. *Control:* See (12) Sooty Mold under General Diseases.

15. *Verticillium Wilt* (oak) — See under Maple.
16. *Wetwood, Slime Flux* — See under Elm.
17. *Mistletoe* — See (39) Mistletoe under General Diseases.
18. *Bark Patch of White Oak* — Small to large, irregular, smooth, light-gray, sunken patches on the dead bark. Trees are not injured.
19. *Bleeding Canker* — Northeastern states. See under Beech and Maple.
20. *Felt Fungus* — Southern states on neglected willow and water oaks. Smooth, shiny, chocolate-brown to almost black growth on the bark. See under Hackberry.
21. *Root-feeding Nematodes* (dagger, lance, needle, pin, ring, root-knot, root-lesion, sheath, spear, spiral, stem, sting, stubby-root, stylet or stunt, *trophotylenchulus*) — May be associated with Root Rots (above) and sickly, declining trees. *Control:* See under Peach.

OCEANSPRAY — See *Holodiscus*

OCIMUM — See *Salvia*

OCONEE-BELLS — See *Galax*

ODONTOGLOSSUM — See *Orchids*

OENOTHERA — See *Evening-primrose*

OKRA — See *Hollyhock*

OLEA — See *Osmanthus*

OLEANDER (*Nerium*); CARISSA, HEDGETHORN, CARANDA or PERUNKILA, NATAL-PLUM (*Carissa*); FRANGIPANI (*Plumeria*); CRAPE-JASMINE (*Tabernaemontana*); CONFEDERATE-JASMINE (*Trachelospermum*)

1. *Leaf Spots, Spot Anthracnose or Scab* — Small to large spots of various colors and shapes on leaves and seedpods. Infected leaves may wither and fall early. *Control:* Pick off and burn spotted leaves. Spraying at 10-day intervals during rainy periods should prove beneficial. Use zineb or maneb.
2. *Bacterial Gall or Knot* (oleander) — Wartlike galls are formed on the branches, shoots, leaves, and even on flowers. Young leaves and seedpods may be distorted and curled. Canker-like tumors are formed on the older branches which are soft or spongy and rough. Such galls darken with age. *Control:* Prune out and burn infected parts. Be sure to dip shears in alcohol between cuts. Propagate only from healthy plants. Control scales, aphids, and mealybugs by spraying regularly with malathion or lindane.
3. *Sooty Mold, Black Mildew* — Gulf states. Black, powdery patches on the foliage following insect attacks. *Control:* Control insects with malathion or lindane sprays.
4. *Cankers, Dieback* — Shoots and twigs die back from discolored cankers. *Control:* Prune out and burn infected parts. Make cuts several inches below any sign of infection. Spraying as for Leaf Spots (above) should be beneficial.
5. *Root-knot* — See under Peach, and (37) Root-knot under General Diseases.
6. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases. May be associated with nematodes (e.g., burrowing, dagger, root-knot, stubby-root).
7. *Rust* (frangipani) — Reddish-brown, later black, powdery pustules on the leaves. *Control:* Same as for Leaf Spots (above).
8. *Mistletoe* (frangipani) — See (39) Mistletoe under General Diseases.

OLIVE — See *Osmanthus*
ONCIDIUM — See *Orchids*

**ONION [COMMON, WELSH or SPANISH, WILD], CHIVES, GARLIC, LEEK,
LILY LEEK, ORNAMENTAL ALLIUM, SHALLOT (*Allium*);
FALSE-GARLIC (*Nothoscordum*)**

1. *Neck Rot, Gray-mold Blight, Leaf Blight* — Widespread. Leaves may die in the field. Soft, sunken, spongy areas on the neck, in the field or more commonly in storage, which spread down into the bulb. A gray mold may grow over and between the bulb scales. Neck and bulb soften and appear somewhat brownish and cooked. Bulbs later mummify and may develop small to large, black, crustlike masses (sclerotia). This is a serious storage problem. White onions are usually much more susceptible than colored types. Bacterial Soft Rot commonly follows. See Figure 49B, and (36) Bulb Rots under General Diseases. *Control:* Sort bulbs well before storage. Avoid wounding. Cure mature bulbs at 90° to 120° F. for 2 to 3 days (or 60° to 80° F. for 2 weeks). Then store only healthy, mature, well-dried onions at 32° to 36° F. with good ventilation in slatted crates. Keep the humidity as low as practical. Collect and burn plant debris after harvest. Spray in the field as for Blast, Downy Mildew, and Purple Blotch (all below) during wet periods. Avoid late fertilizer applications, especially those containing nitrogen. Keep down weeds. Plant in well-drained soil.
2. *Bacterial Soft Rot* — Widespread and destructive. Bulb is water-soaked then mushy, slimy, and usually foul-smelling. Follows injury (sunscald, frost, insects, cultivator wounds, other diseases). *Control:* Same as for Neck Rot (above).
3. *Bulb Rots* — General in moist soils. Leaves often turn yellow or wilt and die back. May collapse. Roots and bulb decay. Bulb may be covered with a white, black, lemon-yellow, bluish-green, or gray mold growth. Bacterial Soft Rot may follow. Loss occurs in both field and storage. See Figure 49B under General Diseases. *Control:* Plant disease-free sets and transplants in clean, well-drained soil. Dip shallot bulbs in Dowicide B (1 ounce in 3 gallons) for 15 minutes just before planting. Long rotation. Keep down weeds. Collect and burn crop debris after harvest. Cure and sort bulbs well before storage as for Neck Rot (above). Keep plants growing vigorously throughout the season. Control other diseases. Onion varieties differ in resistance. Control onion maggots using seed pelleted with aldrin, dieldrin, or Diazinon or apply a 4-inch band of one of these chemicals in the planter furrow. Check with your county agent or extension entomologist and follow the manufacturer's directions. Apply Terraclor (PCNB) to garlic or shallot sets or apply as a dust in the planting furrow. May combine with an insecticide (e.g., aldrin or dieldrin). Avoid injuring bulbs.
4. *Smut* — General, especially in northern states. Elongated, blister-like streaks occur within bulb scales or seedling leaves. Streaks are filled with dark brown to black, powdery masses which later break out. Leaves are curled, swollen, and distorted. Plants are stunted. Most infected seedlings die early. See Figure 25B under General Diseases. *Control:* Set out disease-free sets or transplants or grow seedlings in clean soil. Treat seed in the planter using 1 ounce of thiram or captan for each ounce of seed. Hexachlorobenzene (or HCB) sold as Anticarie 80 has also given excellent control. Follow the manufacturer's recommendations. Commercial growers often drip formaldehyde solution into the planting furrow (1 part formalin to 100 parts of water) using 1 pint to 35 feet of row when the soil surface is rather dry. Nabam and urea-formaldehyde (UF-85, N-dure, Uracide) are also effective liquid treatments at a 1 per cent concentration and applied like formaldehyde. Smut-resistant onions, where adapted: Beltsville Bunching, Evergreen Bunch, Nebuka Bunching, White Welsh, and Winterbeck. Chives is resistant while garlic is apparently immune.

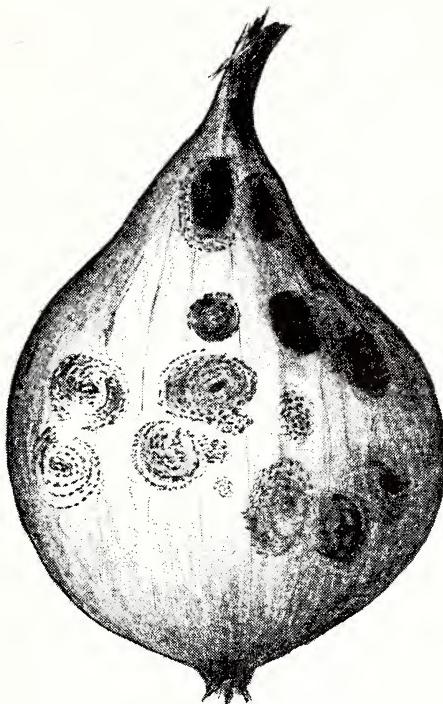
5. *Blast or Tip Blight, Tipburn* — Widespread in northern states. Small, pale, paper-like flecks or spots on the leaves during or following overcast, humid weather. Leaf tips die back. Leaves may turn light tan, then brown, collapse, and die. Bulbs are undersized and immature. *Control:* Plant disease-free sets or transplants in well-drained soil where air circulation is good. Keep down weeds. Four-year rotation. Destroy plant debris after harvest. Avoid overcrowding and overfertilizing with nitrogen. Spray with zineb, maneb, ferbam, or captan, plus spreader-sticker, at weekly intervals, starting when seedlings are 3 to 4 inches tall. Six to 10 applications may be needed. Control thrips (using DDT and malathion) and other diseases.
6. *Downy Mildew* — General. During cool, humid weather, sunken, dull pale green to grayish areas develop in the leaves which become covered with a pale purplish, fuzzy mold. Leaves may turn yellow, die back, and break over. Other plants may be stunted with distorted, pale green leaves. Bulbs are undersized and often soft and immature. Resistant onions (e.g., Calred) appear promising. *Control:* Same as for Blast (above). Red onions have some resistance.
7. *Purple Blotch, Alternaria Leaf Blights* — Widespread in wet seasons. Small to large, gray to purplish, sunken blotches on the leaves, flower stalk, and bulb. A black mold may grow on affected areas in moist weather. Leaves turn yellow, die back, and collapse. Bulbs often rot starting at the neck. Bulb tissue is a deep yellow, then gradually turns wine-colored. May be serious in storage. Common following insect injury or other diseases. Sweet Spanish onion is very susceptible. *Control:* Same as for Neck Rot (above). Treat seed as for Smut (above). Four-year rotation. Plant in well-drained soil. Apply maneb, zineb, or Dyrene at weekly intervals. Add detergent or spreader-sticker to insure wetting of the foliage. Control thrips with DDT, malathion, or dieldrin. Onion varieties differ in resistance. Those with waxy foliage are resistant.
8. *Pink Root, Fusarium Root Rot* — Widespread. Pink Root is most common on onions, garlic, and shallots. Seedlings wilt and die. Leaves often die back from the tips. Plants are stunted. Roots turn pink or yellowish-brown, shrivel, darken, and die. Bulbs may be undersized. Often follows cold, heat, drought, flooding, lack of fertilizer, or other unfavorable growing conditions. *Control:* Plant sets or transplants grown in disease-free soil. Plant in clean, well-drained, fertile soil or fumigate (pages 440-44) infested soil before planting. Keep plants growing vigorously. Five- or 6-year rotation. Onion hybrids and varieties resistant to Pink Root, where adapted: Beltsville Bunching, Colorado No. 6, Early Crystal 281, Eclipse L365, Evergreen Bunch, Excel L35, Granex, L303, and Nebuka Bunching. Much more resistant hybrids should be available soon. Check with your state or extension plant pathologist. *Leek* and *chives* are highly resistant to Pink Root. Resistant shallots: Louisiana Pearl, Evergreen.
9. *Bloat, Stem and Bulb Nematode* (primarily garlic, onion, and shallot) — Seedlings stunted, pale, twisted, and deformed. Infested sets develop much stunted, yellow, and wilted foliage. Outer bulb scales are soft and mealy in texture. Inner bulb scales are swollen. Splitting or double bulbs are common. Plants die gradually. Root- and bulb-rotting fungi and bacteria often follow. Bulbs are lightweight, punky, store poorly. Worse in wet seasons and on heavy soils. See Figure 51A under General Diseases. *Control:* Plant disease-free sets, transplants, or cloves in clean soil. Or plant in soil fumigated in the fall before planting. Use D-D or Telone. Disinfect tools and equipment. Dig up and destroy infected plants when first found. Thoroughly clean up and burn all plant debris after harvest. Rotation 3 or 4 years. Don't save bulbs grown in infested soil! Soak suspicious shallot bulblets (cloves) in hot water (115° F.) for 1 hour. Soak garlic cloves in hot water (110°

F.) and formalin (1:200 or 1 pint of 37-40 per cent formaldehyde in 25 gallons) for 3 hours just before planting.

10. *Root-knot* — Tops sickly, pale green, and stunted. Small, thick-necked bulbs are produced. Small, round swellings form on the roots. Crooked roots are common. *Control:* If serious enough, apply D-D or Telone as for Bloat (above).

11. *Smudge, Anthracnose* (primarily white onions, false-garlic, leek, shallot) — General. Dark green to black, often ringed, unsightly blotches (made up of small dots) on bulb or neck. Usually at side or top. See Figure 145. Stored bulbs may shrivel

Fig. 145. Onion smudge.



slightly or sprout prematurely. *Control:* Plant colored onion varieties or disease-free sets. Otherwise, same as for Neck Rot (above). Provide good ventilation in storage. Rotate.

12. *Yellow Dwarf, Mosaics, Yellows* (false-garlic, garlic, onion, shallot, ornamental allium) — Widespread. Plants yellowed, or with yellow and green stripes. Usually severely stunted and crinkled. Flower stalks are dwarfed, curled, and twisted. Bulbs are undersized. *Shallot* leaves are spindly and yellowed. Seed sets and edible parts may not form. Certain onion varieties may show no symptoms. *Control:* Plant virus-free sets or transplants. Destroy volunteer or wild onions. Isolate bulb- from seed-producing fields as far as possible. Keep down weeds. Control aphids which transmit the virus. Use malathion. Tolerant onion varieties: Beltsville Bunching, Burrell's Sweet Spanish, Colorado No. 6, Crystal Grano, Early Grano, Early Yellow Babosa, Lord Howe Island, Nebuka Bunching, Riverside Sweet Spanish, San Joaquin, Spanish Crystal Grano, Utah Sweet Spanish, White Babosa, White Sweet Spanish, and Yellow Sweet Spanish. Resistant shallots are also available.

13. *Aster Yellows* (garlic, onion, shallot) — Plants gradually turn a bright yellow, often starting first on one side of the plant. All leaves may turn yellow at about the same time. If severe, bulbs may not form. *Control:* Destroy infected plants when first found. Plow under crop debris cleanly after harvest. Use virus-free sets.
14. *Rusts* — Occasional. Attack garlic, false-garlic, onion, shallot, chives, and ornamental allium. Small, light yellow to orange or reddish, then lead-colored to black, powdery pustules on the leaves and stalk. If severe, leaves may turn yellow, wither, and die early. *Control:* Rotate. Collect and burn plant debris after harvest. Keep down weeds. Spraying as for Blast or Downy Mildew (both above) should keep Rusts in check. Use ferbam, zineb, or maneb.
15. *Sunscald* — Bleached, then soft, slippery areas, especially on immature bulbs of white varieties of onions. Bacterial Soft Rot often follows. *Control:* Protect bulbs from hot sun during curing and harvesting by covering with tops. Harvest later in the day.
16. *Minor Leaf Spots and Blights, Tip Dieback* — White, gray, pale green, yellow to pale brown or black spots and blotches on the leaves which may be covered with dark mold growth in damp weather. Leaves often die back from the tip or break over. *Control:* Same as for Blast, Downy Mildew, and Purple Blotch (all above).
17. *Freezing Injury* — Tissues in cut bulbs are water-soaked and more or less transparent with scattered opaque areas. Bacterial Soft Rot commonly follows. *Control:* Avoid storage temperatures below 32° F. Bermuda and Sweet Spanish onions are much more susceptible than the Globe varieties.
18. *Damping-off* — Seedlings wilt and collapse from rot at the soil line. Often occurs in more or less circular patches. *Control:* Follow the best cultural practices. Treat seed and soil as for Smut (above). Spray young seedlings at 5- to 7-day intervals using zineb (1½ tablespoons per gallon).
19. *Verticillium Wilt* — See (15B) Verticillium Wilt under General Diseases.
20. *Scab* (onion) — See (14) Scab under General Diseases.
21. *Bacterial Leaf Streak* (onion) — Colorado. Mottled brown streaks form on older leaves and leaf sheaths in warm weather. *Control:* Same as for Neck Rot (above).
22. *Other Root-feeding Nematodes* (lance, pin, root-lesion, spiral, sting, stylet or stunt, stubby-root) — Associated with stunted, sickly plants. Roots stubby, short, and discolored. May provide wounds for root- and bulb-rotting organisms to enter. *Control:* Same as for Root-knot (above).

ONOCLEA — See Ferns

ONOSMODIUM — See Mertensia

OPHIOGLOSSUM — See Ferns

OPUNTIA — See Cactus

ORANGE — See Citrus

ORANGE SUNFLOWER — See Chrysanthemum

ORCHIDS: ANGRAECUM, CATASETUM, CATTLEYA, CYMBIDIUM, CYPRIPEDIUM, DENDROBIUM, EPIDENDRUM, GRAMMATOPHYLLUM, LAELIA, LYCASTE, MILTONIA, ODONTOGLOSSUM, ONCIDIUM, PHALAENOPSIS, SPATHOGLOTTIS, STANHOPEA, VANDA, and ZYGOPETALUM

1. *Seed Rot, Mold, Seedling Blight* — Common in culture flasks. Seeds rot. Seedlings are weak and collapse. May be covered with mold growth, often blue-green in color.

Control: Sterilize seeds by soaking several hours in small bottles ($\frac{1}{2}$ inch by 2 inches) filled $\frac{1}{2}$ inch deep with distilled water. Then add $\frac{1}{2}$ ounce of distilled water in which a chlorine tablet is dissolved. Shake for 3 to 4 minutes and pour into sterile flasks containing agar to let the seed germinate. Rotate culture flasks evenly to distribute the seed. Then pour off the solution.

2. **Leaf Blight, Pythium Black Rot, Damping-off** — Common in community pots. Round to oval, translucent or water-soaked, dark brown or blackish spots, sometimes with zoned, light brown borders, develop on the leaves. Spots enlarge rapidly in moist weather until the whole leaf may soften, wither, and collapse. Seedlings often wilt and topple over. Pseudobulbs, rhizomes, roots, and flower buds may also rot. **Control:** Destroy infected seedlings. Cut out and burn infected parts on older plants. Carefully remove rotting leaves and pseudobulbs. When dividing plants, sterilize knives by dipping in 70 per cent denatured alcohol. Keep the foliage as dry as possible. Avoid excess moisture. Keep the humidity down. Space plants for good air circulation. Isolate diseased plants. Drench seedlings or dip infected plants, pot and all, for an hour (large plants for 2 or 3 hours) in Bioquin 1 or Natriphene 1:2,000 (1 teaspoonful in $2\frac{1}{2}$ gallons of water) following the manufacturer's directions. If rot continues, repeat the treatment a week later.
3. **Leaf Spots, Leaf Blotch, Anthracnose, Black Spot** — Round to irregular spots on the leaves. Often sunken and sharply defined. Spots may later be ringed. Disease may start at the leaf tips and progress downwards. If severe, leaves may darken and die. **Control:** Spray with Bioquin 1 (1:1,000), fixed copper, or zineb. Keep the humidity down and the foliage as dry as possible. Avoid overfertilizing with nitrogen. Increase both light and air circulation. Do not propagate from infected plants.
4. **Stem, Collar, and Root Rots** — Serious on many orchids. Leaves wilt, wither, and usually collapse from a rotting of the stem base or root collar. Roots may decay. A white or brown mold may grow on the rotting tissues. See also Root Nematodes (below). **Control:** Plant disease-free seedlings in a sterile medium. See Seed Rot (above). Destroy infected plants. Avoid overwatering or wounding plants, excessive humidity, and temperature. Soak plant, pot and all, for an hour in a solution of Bioquin 1 or Natriphene (1 teaspoon in $2\frac{1}{2}$ gallons of water) following the manufacturer's directions.
5. **Petal Blights, Brown Speck, Gray-mold Blight** — Small tan spots on the flowers. May be bordered with delicate pink rings. Spots enlarge in cool, damp weather, forming brown blotches. Petals may be destroyed. A grayish-brown mold may develop on the decaying tissue. **Control:** Carefully cut and burn infected flowers as soon as found. Same cultural practices as for Leaf Spots (above).
6. **Bacterial Soft Rot, Brown Spot or Rot** — Small, soft, water-soaked, dark green, amber-colored, brown or black spots on the leaves. Leaves may soon collapse, turn yellow or brown, mushy, and foul-smelling. Rotting crowns shrivel. Leaves may drop early. Pseudobulbs and rhizomes may develop a soft, black, foul-smelling rot. **Control:** Avoid wounding plants. Remove rotted plant parts promptly. Separate diseased from healthy plants. Disinfect knife between cuts by dipping in household bleach or mercury (e.g., Semesan or a 1:1,000 solution of mercuric chloride. See page 427 for precautions). Keep plant foliage as dry as possible. Separate diseased from healthy plants. Dipping plants as for Leaf Blight (above) is beneficial. Or swab small infected areas on leaves with a 1:1,000 solution of mercuric chloride. Repeat as necessary.
7. **Rusts** — Yellowish-green spots on the upper leaf surface with bright, yellowish-orange, powdery pustules on the corresponding underside. Blooms may not develop. Plants are stunted. **Control:** Destroy rusted leaves. Otherwise same as for Leaf Spots (above).

8. *Fusarium Wilt* (cattleya) — Leaves wilt, wither, and drop off. Pseudobulbs, roots, and rhizomes die. Flowers are stunted and fewer in number. *Control:* Plant in a sterile rooting medium. Destroy infected plants.
9. *Mosaics, Mottle, Leaf Necrosis* (many genera) — General. Symptoms variable depending on the viruses involved, the orchids, and environmental conditions. In *Cattleyas* and related orchids infection is expressed as yellowish or sunken, reddish-brown to black patterns, ringspots, irregular spots, mottling, or streaks in the leaves. Leaves may die early. Fewer and smaller flowers are produced. New leaf growth is stunted, cupped, and often pock-marked. In *Cymbidiums* symptoms are variable in pattern and severity. The spots are often first elongated and yellowish. Later these areas enlarge and become more defined. Leaves are mildly or severely mottled. Dark streaks, spots, rings, and patterns may develop in the older leaves. Severely infected leaves may drop early. Growth may be stunted. In *Spathoglottis* diamond-shaped, dead spots are formed. New growth is mildly to severely mottled. Later, concentric ring patterns are formed. Small, solid, elliptical, reddish to reddish-brown spots are formed in *Miltonia* leaves. In *Oncidium* conspicuous, irregular, yellowish spots and streaks or a light green mosaic mottle develops in the leaves. Dark brown to black spots or sunken streaks form on the underside of *Epidendrum* leaves. Halo-like, brownish rings with dark centers form in very young leaves. In *Odontoglossum* an irregular, light green to yellowish mosaic pattern is formed. Or streaks and small rings develop in the leaves which become rusty-colored or dead in some cases. Leaves may be stunted. Narrow, longitudinal, light to dark green streaks form in *Lycaste* leaves. *Control:* Destroy infected plants. When dividing or harvesting flowers, disinfect pruning tools between cuts by dipping in 70 per cent denatured alcohol. Keep healthy and virus-infected plants separated. Select virus-free propagation stock and seedlings. Malathion sprays control aphids which transmit the viruses. Keep down weeds in and around growing orchids. Check with the plant pathology department at your land-grant institution concerning antivirus antisera and special ring tests for determining infected plants. Use seedlings since viruses do not invade the seed of orchids.
10. *Flower Breaking* (cattleya, cymbidium, dendrobium, oncidium, spathoglottis, vanda, etc.) — Leaves may show an irregular, mild to severe mosaic mottling and some malformation. Flower petals may be mottled, somewhat distorted, or show irregular and abnormal color streaks and blotches. Flower sepals and petals may be rolled and twisted. Virus is symptomless in some plants. The center shoot of *Spathoglottis* may become blackened. *Control:* Same as for Mosaics (above).
11. *Ringspots* (cymbidium, dendrobium, laelia, miltonia, odontoglossum, stanhopea, vanda) — Symptoms variable. Small, dead (or light green to pale yellow) spots, lines, or rings — partial or complete — develop on the upper leaf surface. The single or concentric rings may later be totally dead enclosing a central light green or yellow "island." Rings may overlap or run together forming large compound patterns. Some leaves may turn yellow and drop early. If severe, the entire plant may die. *Control:* Same as for Mosaics (above).
12. *Leaf Nematodes* — Angular, brown or blackish spots wedged between the larger veins. Infested leaves later die. The stem and bulb nematode may cause some malformation of the lower leaves which become brittle and break off easily. Flower buds may turn yellow, then brown and shrivel without opening. *Control:* Propagate from healthy plants into a sterile rooting medium. Keep foliage as dry as possible. Cut off and burn infested leaves. Spray weekly with malathion plus spreader-

sticker. Keep orchids away from ferns, phlox, and other susceptible plants. Disinfest *Vanda* cuttings by soaking in hot water (115° F.) for 10 minutes.

13. *Root Nematodes* (e.g., root-lesion or meadow) — Usually found associated with root and bulb rots and yellowish leaves. Older leaves die prematurely. *Control:* Same as for Stem Rots (above).
14. *Tipburn* (cymbidium) — Tips of older leaves darken and die back. Various molds may grow on the dead tissue in moist weather. *Control:* Plant in light, well-drained, sterile soil low in soluble salts. Apply fertilizers frequently but in very dilute form. Use slowly available forms of nitrogen. Check with your florist, garden supply dealer, or extension horticulturist.

For additional information on orchid problems read a book such as The Orchids: A Scientific Survey, published by the Ronald Press Co.

OREGON-GRAPE — See Barberry

ORNITHOGALUM — See Tulip

OSAGE-ORANGE (*Maclura*)

1. *Rust* — Southern states. Minor disease. Reddish-brown, powdery pustules on the leaves. *Control:* Unnecessary.
2. *Leaf Spots, Leaf Blight* — Unimportant. Small to large, tan, gray, or "cottony" spots on the leaves. *Control:* Collect and burn fallen leaves.
3. *Verticillium Wilt* — See under Maple, and (15B) Verticillium Wilt under General Diseases.
4. *Mistletoe* — See (39) Mistletoe under General Diseases.
5. *Damping-off* — See under Pine.
6. *Root Rot* — See (34) Root Rot under General Diseases.

OSIER — See Dogwood and Willow

OSMANTHUS [CHINESE, HOLLY], SWEETOLIVE, WILD OLIVE, DEVILWOOD (*Osmanthus*); OLIVE (*Olea*)

1. *Leaf Spots, Black Leaf Spot, Anthracnose* — Small to large spots on the leaves, often black in color. Spots may also occur on olive fruit. *Control:* Collect and burn fallen leaves. Keep trees pruned. If serious enough, try spraying during rainy periods using zineb, maneb, or captan.
2. *Sooty Molds, Black Mildew* — Gulf states. Black, moldy patches on the leaves. Often follows insect attacks. *Control:* Apply malathion sprays to keep insects in check.
3. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases. May be associated with nematodes (e.g., meadow or root-lesion, citrus).
4. *Root-knot* — See under Peach, and (37) Root-knot under General Diseases.
5. *Bacterial Knot* (olive) — California. Irregular, spongy to hard, knotty galls, up to several inches in diameter, may appear on leaf and fruit stems, twigs, branches, trunk, and roots. Shoots may be stunted and die back. Entire trees may die. *Control:* Cut out galls carefully, disinfecting tools between cuts by dipping in 70 per cent denatured alcohol or household bleach. Paint over larger wounds with bordeaux paste or treat galls as outlined under Peach, Crown Gall. Plant healthy nursery stock. Follow the spray program recommended for your area.
6. *Mistletoe* (osmanthus) — See (39) Mistletoe under General Diseases.
7. *Verticillium Wilt* (olive) — See (15B) Verticillium Wilt under General Diseases.

OSMARONIA — See Rose

OSMORHIZA — See Celery

OSMUNDA — See Ferns

OSOBERRY — See Rose

OSTRYA — See Birch

OSWEGO-TEA — See Salvia

OXALIS, WOODSORREL, LADYS-SORREL, SHAMROCK (*Oxalis*)

1. *Leaf Spots, Tar Spot* — Spots of various shapes, colors, and sizes on the leaves. *Control:* Pick off and burn spotted leaves. If serious enough, spray at 10-day intervals using zineb, maneb, or fixed copper.
2. *Powdery Mildew* — White, powdery blotches on the foliage. *Control:* Spray two to three times, 10 days apart, with Karathane.
3. *Rusts* — Yellow-orange, reddish-brown, or black, powdery pustules on the leaves. May be serious. Alternate hosts include wild grasses, corn, and Oregon-grape. *Control:* If serious enough, apply ferbam or zineb at 10-day intervals.
4. *Stem Nematode* — See (20) Leaf Nematode under General Diseases.
5. *Root Rot* — See under Geranium, and (34) Root Rot under General Diseases.
6. *Seed Smut* — See (11) Smut under General Diseases.
7. *Curly-top* — See under Beet, and (19) Curly-top under General Diseases.

OXEYE, OXEYE DAISY — See Chrysanthemum

OXLIP — See Primrose

OXYBAPHUS — See Four-o'clock

OXYDENDRUM — See Sorreltree

PACHISTIMA — See Bittersweet

PACHYCEREUS — See Cactus

PACHYSANDRA, ALLEGANY; JAPANESE or MT. SPURGE (*Pachysandra*)

1. *Leaf Blight, Dieback, Stem Canker* — Large, brown blotches on the leaves. Leaves are later brown to black and blighted. Stems are withered by dark cankers. Salmon-pink pustules cover affected parts in wet weather. Plants die out in patches. Common after injury. *Control:* Control scales by malathion sprays. Mulch plants for the winter with a light material which does not hold moisture. Avoid excess moisture and overcrowding. Clean out and burn all infected plants. Spray the remainder thoroughly with bordeaux mixture. Repeat 7 to 10 days later. Or apply ferbam, or captan, plus spreader-sticker, three or four times, 7 to 10 days apart. Thin out thick beds to increase light and air circulation.
2. *Leaf Spots* — Small spots on the leaves. *Control:* Rarely necessary. Spray as for Leaf Blight (above). Thin out thick beds.
3. *Root-knot* — Small galls form on the roots. See (37) Root-knot under General Diseases.
4. *Other Root-feeding Nematodes* (dagger, lance, pin, root-lesion, spiral, stylet or stunt) — Associated with stunted, sickly plants. *Control:* Same as for Root-knot (above).

PAEONIA — See *Delphinium*

PAGODATREE — See *Honeylocust*

PAINTED-CUP — See *Snapdragon*

PAINTED DAISY — See *Chrysanthemum*

PAINTED-TONGUE — See *Tomato*

PAK-CHOI — See *Cabbage*

PALE LAUREL — See *Blueberry*

PALMS: QUEEN PALM or PLUMY-COCONUT (*Arecastrum*);

SUGAR (*Arenga*); FISHTAIL (*Caryota*); COCONUT (*Cocos*);

CANARY DATE or DATE (*Phoenix*); CUBAN ROYAL and PUERTO RICO (*Roystonea*); PALMETTO, CABBAGE (*Sabal*); WASHINGTON (*Washingtonia*)

1. *False Smuts, Leaf Scab* (date, palmetto, queen, royal, sugar, Washington) — Widespread. Numerous, small, yellow spots and small, black, hard warts or scabs on the leaves. Severely infected leaves soon die. *Control:* Cut out and burn infected leaves or parts of leaves. Indoors, keep water off the foliage. When disease is first evident, spray with a copper fungicide. Repeat sprays during cool, rainy weather. Thiram, zineb, or ziram may do just as well without causing injury.
2. *Leaf Spots or Blight, Anthracnose* (coconut, date, fishtail, palmetto, queen, royal, Washington) — Widespread. Small to large, round to irregular spots of various colors on the leaves. Spots may run together forming large blotches. A brown blight may work downward from the leaf tip. Infections may cause rotting of the leaf bases. Leaves may die. See Figure 146. *Control:* Indoors, maintain sufficient light. Otherwise same as for False Smuts (above).
3. *Stem (Trunk) and Root Rots, Wilt* (coconut, date, royal, Washington) — Leaves may turn gray or yellow and wilt progressively up the plant. Later fall. Plants unthrifty, often stunted, lack vigor. Gumming may be evident on the trunk. Small, black, club-shaped fruiting bodies may grow out from decaying roots. May be associated with nematodes (e.g., burrowing, dagger, spiral). *Control:* Plant potted palms in sterilized soil (pages 437-44). Keep plants growing vigorously through fertilizing and watering. Avoid wounding roots or stem (trunk). Coat wounds promptly with tree wound dressing (page 25).
4. *Bud Rot, Wilts, Trunk Rot, Leaf Drop* (coconut, palmetto, queen, Washington) — Soft, spongy, rot of stem (trunk) base. Leaves wilt and die in several months. Terminal bud develops a wet rot. Bud loosens and withers. *Control:* Cut out crown, infected buds, and leaves from diseased trees. Avoid trunk injuries.
5. *Black Scorch, Heart Bud Rot* (coconut, date) — Dark brown to black hard spots in the leaves, leaf stalks, buds, and flowers. If severe, the heart leaves dry up. *Control:* Cut out and bury or burn all infected plant parts. Disinfect pruning cuts. Copper sprays during rainy periods may be beneficial.
6. *Bacterial Wilt* (coconut, Cuban royal) — Lower leaves turn gray and wilt. Later the trunk exudes gum. Finally the crown collapses. *Control:* Unknown. Plant disease-free plants in sterilized soil. Destroy infected plants when found.
7. *Penicillium Leaf Base Rot, Bud Rot, Trunk Canker, Gummosis* (coconut, date, queen, Washington) — Serious along the southern Pacific Coast. Symptoms variable. *Date palms:* Linear streaks and a leaf base rot occur. *Washington palms:* Stunted, deformed leaves, dwarfed terminal growth, and bud rot. *Queen or Coconut:* Trunk canker. Leaf bases rot progressively upward on the tree. Trunk is weakened. Later breaks. *Control:* Treat trunk cankers early. Grow resistant Washington

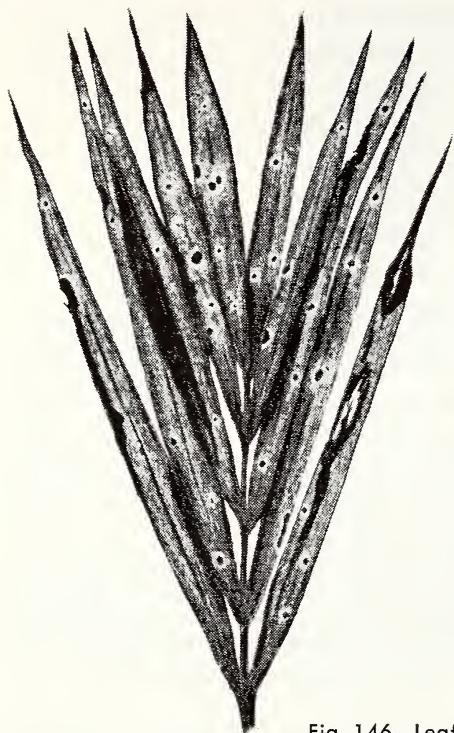


Fig. 146. Leaf spot of palm.

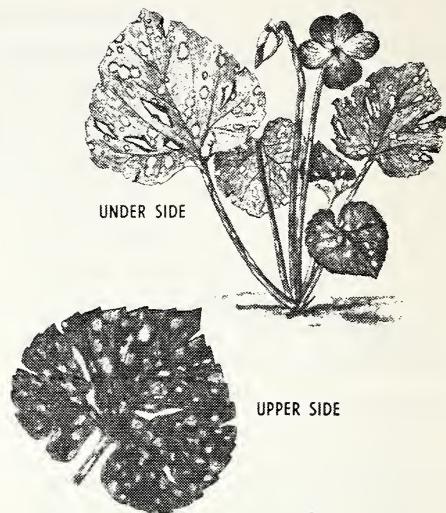


Fig. 147. Violet scab or spot anthracnose.

palms (*Washingtonia robusta*). Check with the Department of Plant Pathology, University of California, Riverside, California.

8. *Root-knot and Other Nematodes* (e.g., burrowing, lance, needle, root-lesion or meadow, spiral, stubby-root) — See under Peach, and (37) Root-knot under General Diseases.
9. *Black Mildews* (palmetto) — Gulf states. Black, powdery patches on the leaves. *Control:* Spray with a fungicide plus malathion or lindane to control scales, mealybugs, aphids, and other insects. Follow the manufacturer's directions carefully.
10. *Sunscald* — Indoor problem. Large, dry, leaf blotches with yellow centers and brown margins. *Control:* Provide more shade.
11. *Withered Leaf Tips* — Indoor problem. Tips of leaves or even entire leaves may wither and die after being moved to a new location. *Control:* Avoid sudden changes in humidity (e.g., from a damp greenhouse to a dry living room). Buy plants with tough, dark green leaves. Feed lightly with a balanced fertilizer. Avoid overwatering. Repot only when absolutely necessary. Keep plants out of air drafts. Raise the humidity in a dry room or spray leaves occasionally with water at room temperature.
12. *Chlorosis* — Southeastern states. See under Walnut.
13. *Thread Blight* — Southeastern states. See under Walnut.
14. *Fruit Rots* (date) — Fruit rot. See (32) Fruit Rot under General Diseases. *Control:* Check with your state or extension plant pathologist.
15. *Felt Fungus* — Southeastern states. See under Hackberry.

PANDANUS — See Screwpine**PANSY [HORNED, TUFTED or BEDDING PANSY, VIOLET], VIOLET
[CONFEDERATE, SWEET or FLORISTS', WILD] (*Viola*)**

1. *Anthracnose, Leaf Spots, Spot Anthracnose or Scab* — General. Small to large leaf spots of various sizes, shapes, and colors. Often with a distinct, dark margin. Spots may enlarge and run together forming irregular blotches. Similar spots may occur on the stems, petioles, flower petals, and seed capsules. Infected petals are distorted. Flowers may fail to produce seed. Entire plant may die. See Figure 147. *Control:* Collect and burn infected plant parts. Space plants. Rotate plantings. Destroy old tops in the fall. Indoors, keep water off the foliage and avoid dampness. Plant disease-free plants in a warm, dry location. Spray at 5- to 7-day intervals during wet weather using zineb, captan, ferbam, maneb, or fixed copper. Control insects with malathion. Plant disease-free seed. If in doubt, treat seed as for Wilt (below).
2. *Gray-mold Blight, Botrytis Blight* — Common in wet springs. Soft, grayish-brown, rotted spots in the leaves, stems, and flower clusters. Spots enlarge rapidly in damp weather. Affected parts may be covered with a gray mold and become slimy. *Control:* Same as for Anthracnose (above).
3. *Powdery Mildew* — Whitish patches of mildew on the leaves. If severe, leaves may turn brown and wither. *Control:* If serious enough, apply sulfur or Karathane two or three times, 10 to 14 days apart. Do not use when the temperature is 85° F. or above.
4. *Wilt, Root Rots, Stem or Crown Rots, Southern Blight, Damping-off* — Leaves are stunted, yellowish, finally die. Stem base and roots decay; may be dry, mushy or slimy, and foul-smelling. Plants turn yellow, wilt, and gradually or suddenly die. Seedlings wilt and collapse. May be associated with root-feeding nematodes. *Control:* Where practical, plant in light, well-drained soil which is sterilized. See "Soil Treatment Methods and Materials" in the Appendix. Avoid overwatering. Rotate. Treat seed with Semesan, captan, thiram, dichlone, or chloranil.
5. *Smuts* — Leaves, stems, flowers, flower stalks, and seed may be infected. Large, elongated, dark purple blisters on the foliage which later burst open to release black, powdery masses. Petioles are deformed. *Control:* Dig up and burn infected plants when first found. Treat seed as for Wilt (above) or plant only disease-free stock. Practice rotation.
6. *Downy Mildew* — Irregular, pale leaf spots with a light grayish-purple mold on the underleaf surface in damp weather. Leaves rot quickly in wet weather. Plants may droop and die without showing definite dead areas. *Control:* Same as for Anthracnose (above).
7. *Rusts* — General. Pale green spots on the upper leaf surface and yellow "cluster cups" on the corresponding underside. Rust also occurs on the swollen parts of veins, petioles, and stems. Later, the pustules turn light brown and finally dark brown or black. Flowering may be reduced. Alternate hosts: wild grasses (*Andropogon*) or none. *Control:* Same as for Anthracnose (above).
8. *Oedema, Corky Scab* — Indoor problem. Small, corky, or wartlike growths on the leaves and flower stalks. Affected plant parts become dry and brittle. *Control:* Increase air circulation. Avoid overwatering. Lighten or cultivate the soil. Control insects with malathion sprays.
9. *Mosaics, Calico, Flower Breaking* — Flower petals show white or light streaks or blotches. Flowers are often dwarfed and deformed. Leaves are slightly curled and yellowed, mottled green and yellow. See (16) Mosaic under General Diseases. *Control:* Buy virus-free plants or start from seed. Destroy infected plants when

first found. Keep down weeds. Control aphids which transmit the viruses. Use malathion.

10. *Root Nematodes* — Plants may appear unthrifty and sickly. Small wartlike galls on the roots (Root-knot) or sunken brown areas (Dagger, Lance, Root-lesion, Spiral, Stylet or Stunt). Roots may be stunted, stubby, bushy, and decayed. *Control:* Set out disease-free plants in clean or sterilized soil (pages 437-44).
11. *Curly-top* — Western states. Shoots are stunted. Form rosettes. Flowers dwarfed and produce few seed. *Control:* Apply malathion and DDT to control leafhoppers which transmit the virus. Otherwise, same as for Mosaics (above).
12. *Ringspot* — Widespread. Numerous dead rings with green centers develop in the leaves. *Control:* Same as for Mosaics (above).
13. *Aster Yellows* — Plants stunted and bright yellow. *Control:* Same as for Curly-top (above).
14. *Sooty Mold* — Black, moldy patches on the leaves following insect attacks. *Control:* Spray with malathion when insects are first seen.
15. *Leaf Nematode* — New leaves are dwarfed and distorted. Plants may not flower. Stalks are stunted. The base of the petiole may be swollen and irregular. *Control:* Move to a new bed. Start with new, disease-free plants. If you must use plants from the old, infested bed, first soak the plants in hot water (110° F.) for 30 minutes. Cool, then plant.

PAPAVER — See Poppy

PAPER-MULBERRY — See Fig

PARKINSONIA — See Honeylocust

PARIS DAISY — See Chrysanthemum

PARSLEY — See Celery

PARSNIP — See Carrot

PARTHENOCISSUS — See Grape

PARTRIDGE-BERRY — See Buttonbush

PASQUEFLOWER — See Anemone

PASSIONFLOWER (*Passiflora*)

1. *Leaf Spots* — Spots of various sizes, shapes, and colors on the leaves. Spots may also occur on the fruit, causing shriveling. *Control:* Apply zineb, maneb, or fixed copper just before wet periods. Prune annually to thin out plants.
2. *Stem or Collar Rot, Southern Blight* — Plants turn yellow and wilt from a rot at the soil line. Rot may be covered with a white mold growth. The bark rots, exposing the wood. *Control:* Remove and burn infected plants. Plant in well-drained soil which is near neutral (pH 7).
3. *Gray-mold Blight* — Plants may wilt and die. See under Begonia, and (5) Botrytis Blight under General Diseases.
4. *Root-knot* — Southern states. Plants stunted and sickly, especially on sandy soils. See (37) Root-knot under General Diseases.
5. *Seedling Wilt, Anthracnose, Stem and Leaf Spot* — Uncommon. Seedlings wilt and die. *Control:* Same as for Leaf Spots (above).
6. *Root Rot* — See (34) Root Rot under General Diseases.

PASTINACA — See Carrot**PATIENCE PLANT — See Balsam****PAULOWNIA, EMPRESSTREE, PRINCESSTREE (*Paulownia*)**

- Leaf Spots* — Spots occur on the leaves in rainy seasons. *Control:* Collect and burn fallen leaves. Where practical, spray several times during rainy periods, using zineb, maneb, or fixed copper.
- Wood Rot* — See under Birch, and (23) Wood Rot under General Diseases. *Control:* Avoid wounding the bark on the trunk. Paint wounds promptly with tree wound dressing (page 25). Fertilize and water to maintain tree vigor.
- Root Rot* — See (34) Root Rot under General Diseases.

PAWPAW (*Asimina*); ROLLINIA

- Leaf Spots, Leaf Blotch* — Widespread. Small to large, round to irregular spots and blotches of various colors on the leaves. *Control:* Collect and burn leaves in the fall. Prune to keep trees thinned out. If necessary, spray several times during rainy periods, 10 days apart. Try using zineb, maneb, or fixed copper.
- Twig and Branch Cankers, Diebacks* — Twigs and branches die back due to discolored cankers. *Control:* Prune out and burn infected parts. Make cuts several inches beyond any sign of infection. See under Maple.
- Wood Rots* — See under Birch, and (23) Wood Rot under General Diseases.
- Sooty Mold* — Black, moldy patches on the leaves and twigs. *Control:* Apply malathion sprays to control insects.
- Fruit Rot* — Fruits spotted, later rot. *Control:* Apply zineb or captan sprays during rainy periods as fruits are growing.

PEA, GARDEN (*Pisum*); ROSARYPEA (*Abrus*); BUTTERFLY-PEA (*Centrosema, Clitoria*); CROWNVETCH (*Coronilla*); CROTALARIA; HYACINTH-BEAN, TWINFLOWER (*Dolichos*); SWEETPEA, EVERLASTING or PERENNIAL PEA, BEACH PEA (*Lathyrus*); LENTIL (*Lens*); LUPINE [ANNUAL, BLUE, PERENNIAL, RUSSELL, SUNDIAL or QUAKER BONNETS, TEXAS or BLUEBONNET, YELLOW, WASHINGTON, and WHITE] (*Lupinus*); SENSITIVE PLANT (*Mimosa*); BUSH-PEA, GLOWING GOLD, GOLDEN-PEA, AARONS-ROD (*Thermopsis*); VETCH (*Vicia*); ASPARAGUS-BEAN or YARDLONGBEAN (*Vigna*)

- Fusarium Wilt, Near Wilt, Root Rot* — Widespread in northern states, especially on garden pea. Caused by two races of the same or closely related fungi. Yellowish, dwarfed plants which often wilt and die starting with the lower leaves at about blossoming time. Leaflets are small, rolled, and distorted. Plants may break over near the soil line. Yellow-orange to a brownish-black (Pea Wilt) or brick-red (Near Wilt) streaks inside the lower part of the stem. Wilt often occurs in patches. Pods normally do not form. Roots decay. Seedlings damp-off. Often associated with nematodes. *Control:* Avoid overfertilization and overcrowding. Treat seed as for Seed Rot (below). Rotate 4 years or more. If practical, plant in sterilized soil (see pages 437-44 in the Appendix) or drench soil for flowers using a 1:2,000 solution of mercuric chloride (1 pint to 5 feet of row). Plant wilt-resistant pea varieties, where adapted: Ace, Alaska W.R., Alcross, Alderman, Apex, Bruce, Canner, Climax, Delwiche Commando, Dwarf Alderman, Early Harvest, Early Perfection W.R., Early Sweet 11, Eureka, Extra Early, Freezer 37, Freezonian, Glacier, Green Giant, Hardy, Horal, Improved Gradus, Jade, King, Laxton 7, Laxton's

Progress, Lola, Midfreezer Emerald, Morse Market, New Era, New Season, New Wales, Pacemaker W.R., Pacific Market 40, Penin, Pride, Profusion, Ranier, Resistant Early Perfection 326, Resistant Surprise, Shasta, Small Sieve Freezer, Stratagem, Surpass, Teton, Thomas Laxton W.R. or 251, Wisconsin Early Sweet, Wisconsin Merit, Wyola, and Yellow or Green Admiral. Plant in well-drained soil. *Pea* varieties normally resistant to Near Wilt: Delwiche Commando, New Era, New Season, New Wales, Horal, Horsford, and Rogers 95.

2. *Root Rots, Foot Rots, Southern Blight, Crown Rots, Stem Canker* — General and serious in wet weather. Seeds rot. Stand is poor. Seedlings sickly, shrivel, and die. Older plants often sickly, stunted, and yellow. May collapse. Plants may wilt and die at or near flowering time. Crown and roots are discolored and rotted. May be covered with mold growth. Often occurs in patches which gradually enlarge during the season. Plants are easily pulled up. Often associated with Fusarium Wilt or Near Wilt, Seed Rot, and Nematodes. See Figure 47D. *Control:* Treat seed as for Seed Rot (below). Plant early in a fertile, well-drained soil. Four- to 6-year rotation. Avoid close and deep cultivating. Keep plants growing vigorously. If practical, dig up and burn infected plants. *Pea* varieties which are somewhat resistant to Fusarium or Aphanomyces Root Rots: Acquisition, Green Admiral, Freezonian, Horal, Pacific Freezer, Premier Gem, Rice No. 300, Resistant Thomas Laxton 251, Selkirk, Sutton's Ideal, Wando, and World's Record. For flowers, drench the soil with mercuric chloride (see Fusarium Wilt, above) or plant in sterilized soil.
3. *Powdery Mildews* — General. White to gray powdery coating on the leaves, pods, and stems. Leaves may turn yellow, wither, and die. Plants may be dwarfed. See Figure 148B. *Control:* Plant plump, disease-free seed. Apply sulfur or Karathane several times, a week apart. Do not apply when the temperature is over 80° F. or when plants are in flower. Rotate. Increase air circulation and keep water off the foliage. Space plants. Resistant *pea* varieties may be available soon.
4. *Seed Rot, Damping-off* — General. Seeds rot. Seedlings sickly, wilt, and collapse. Stand is thinned. *Control:* Treat *sweetpea* seed by soaking 1 minute in alcohol followed by a 20-minute soak in a 1:1,000 solution of mercuric chloride. Wash treated seed in running tap water for 3 to 5 minutes. Dry and dust as for other seed. Treat other seed with thiram, captan, dichlone, or Semesan. Avoid deep planting and poorly drained soil. If damping-off starts, apply the Shot-gun Soil Drench (page 92).
5. *Bacterial Leaf Spots and Blights* — General. Small to large, dark green, water-soaked spots on the pods, petioles, stem, leaves, and blossoms. Spots later dry up and turn yellow or brown. Flowers are killed or young pods shrivel. Pods may appear scalded and cracked. Branches or entire plants may wilt and die. Often follows strong winds, late spring frosts, or hail. *Control:* Plant disease-free seed grown in western states. Treat seed as for Seed Rot (above). Rotate at least 2 years. Keep down weeds. Do not work among wet plants. Plant early in well-drained soil.
6. *Virus Complex* (mosaics, streaks, stunt, mottle, wilt) — General. Symptoms change with the plant, variety, viruses involved, age of plants, weather conditions, and other factors. Leaves generally mottled (lightly to severely) or spotted with a yellow, light green, and dark green mosaic pattern. Plants may be dwarfed and yellowish with crinkled, curled, and distorted leaves and pods. Light brown, reddish-brown, or purplish streaks may develop on the stem and petioles (Streak). Young shoots may be stunted and "bushy." Plants may wilt, even die. Flowers often "broken" with white streaks and blotches. Pea pods may be spotted, distorted, twisted, roughened, or few in number. Seed formation is often abortive. See Figure 148. *Control:* Keep down weeds. Use malathion at least weekly to control aphids and other insects which transmit the viruses. Plant seed from virus-free

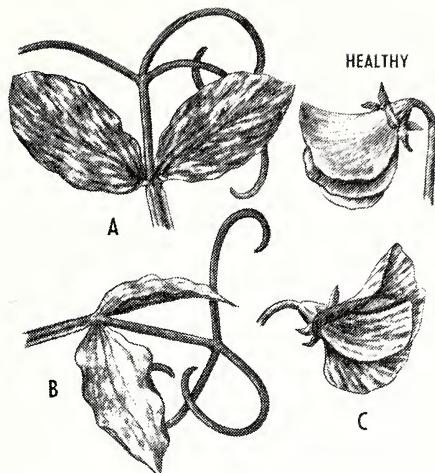


Fig. 148. A. Mosaic of sweetpea, leaves, B. Powdery mildew of sweetpea, C. Mosaic or flower breaking.

plants as early as possible. Destroy infected plants when first found. Burn plant refuse after harvest. Pea varieties resistant to one or more viruses: Horal, Hundred-fold, Little Marvel, Morse Market, New Era, New Season, New Wales, Pride, Resistant Surprise, Wisconsin Early Sweet, and Wisconsin Perfection.

7. *Spotted Wilt, Ringspot* — Yellow, brown, or purple rings, often zoned, or small, round, brown, or purple spots on the leaves. Leaves may be somewhat mottled, distorted, and misshapen. Discolored, circular patterns may appear on the flowers. *Control:* Control thrips which transmit the virus. Use DDT and malathion. Destroy infected plants. Keep down weeds.
8. *Ascochyta and Mycosphaerella Blights, Stem Rot, Foot Rot, Leaf and Pod Spot* — General in wet seasons. Light brown, dark brown, black, or purplish streaks on the stem. Stems may be darkened and girdled, killing the portions beyond. Leaf spots are round to irregular with light or dark centers and darker margins. Spots may run together forming brownish-purple blotches. Black dots may be sprinkled in diseased areas. Sunken spots occur on the pods. Young pods may be distorted and wither. *Control:* Plant large, plump, disease-free seed, grown in western states, in well-drained soil. Treat seed as for Seed Rot (above). Three- to 5-year rotation. Destroy plant debris after harvest. Burn or bury deeply. Keep down weeds. The pea variety Perfection (Advancer) has some resistance. Avoid overwatering. Spray sweetpeas with ferbam, zineb, or captan.
9. *Downy Mildew* — General. Irregular, water-soaked, yellow to brown blotches on the upper leaf surface and white, light violet, grayish-brown, or almost black mold growth on the underleaf surface. Leaves curl downward, gradually wither and die. Yellowish spots on pea pods which are filled with mealy, white mold growth. Pods are distorted with spots turning dark brown. Young plants are very susceptible. Stems may be killed. *Control:* Plant disease-free seed grown in western states. Four-year rotation. Keep down weeds. Plant in well-drained soil. Destroy plant debris after harvest. Apply zineb, maneb, or fixed copper, plus spreader-sticker, weekly during cool, wet periods.
10. *Septoria Blight, Leaf Spot or Blotch* — Widespread but infrequent. Yellowish spots at the margins of leaves which later enlarge and turn brown. Centers may later be sprinkled with black dots. Leaves often wither and die. Young plants may die.

- Control:* Same as for Downy Mildew (above). *Pea* varieties (e.g., Perfection) have some resistance.
11. *Anthracnose, Leaf and Pod Spot* — Widespread and serious. White or gray to brown sunken spots with dark margins on leaves, pods, flowers, and stems. Spots may enlarge and leaves wilt, wither, and fall early. Commonly follows Ascochyta Blights. Shoots and flower stalks may wilt and wither starting at the tips. Drying pods blanch and shrivel. *Control:* Same as for Ascochyta Blights (above). Spray as for Downy Mildew (above). Captan or ferbam may also be used. Fertilize and water to keep plants growing vigorously. Do not plant near apple or privet.
12. *Rusts* — Unimportant. Small, cinnamon-brown to dark brown, dusty pustules on the leaves. Mostly on the underleaf surface. Causes decreased vigor. See (8) Rust under General Diseases. *Pea* varieties differ in resistance. Late-maturing varieties are more commonly infected. Alternate hosts may include spurge (*Euphorbia*) and wheatgrass (*Andropogon*).
13. *Fasciation, Leafy Gall, Crown Gall* — Primarily a disease of sweetpea. Very short, thick, strap-shaped, fleshy stems (witches'-brooms) develop near the soil which form distorted and misshapen leaves. Plants are stunted. Blossoming and fruit set is reduced. See Figure 42A under General Diseases. *Control:* Plant disease-free seed in clean or sterilized soil (pages 437-44). Treat soil for *sweetpea* as for Fusarium Wilt (above). Treat seed as for Seed Rot (above).
14. *Root-knot, Cyst Nematodes* — Southern states and indoors in the north. Oval or elongated galls and cysts formed along the roots. Plants are stunted, yellowish, and grow slowly. Varieties differ in resistance. Check with your extension horticulturist or plant pathologist. See (37) Root-knot under General Diseases.
15. *Gray-mold Blight, Blossom and Shoot Blight, Pod Rot* — General on *sweetpea*. Flowers spotted and rot in damp weather. Brown blotches develop on leaves and pods. Base of stem may rot causing plants to wilt and die. A gray mold may grow on affected areas in damp weather. *Control:* Same as for Downy Mildew (above).
16. *Other Leaf Spots and Blights, Pod Spots, Scab* — Spots of various sizes, shapes, and colors on the leaves. Leaves may be stunted and distorted or wither and drop off. May start at the base of the plant and progress upwards. Pods may be spotted and distorted. May be covered with mold growth. *Control:* Pick off and burn affected leaves. Plant disease-free seed in clean or sterilized soil. Dust or spray as for Downy Mildew (above) starting about 3 weeks before leaf spot usually appears. Rotate. *Pea* varieties differ in resistance. Indoors, lower the humidity and keep water off the foliage. Space plants.
17. *Verticillium Wilt* — Brown discoloration inside the stem near the soil line. See (15B) Verticillium Wilt under General Diseases.
18. *Bud Drop* (*sweetpea*) — Young flower buds turn yellow and drop instead of opening. Primarily an indoor problem. *Control:* Provide extra light during overcast weather. Avoid overwatering and overfeeding with a fertilizer high in nitrogen. Use a balanced fertilizer based on a soil test.
19. *Bacterial Wilt* — See (15C) Bacterial Wilt under General Diseases.
20. *Black Walnut Injury* — Plants growing under black walnut trees wilt and die. *Control:* Do not grow plants within 50 feet of these trees.
21. *Other Root-feeding Nematodes* (dagger, lance, nacobus, pin, reniform, ring, root-lesion, spiral, stem, sting, stubby-root, stylet or stunt) — Mostly southern states. May be associated with sickly, stunted plants. *Control:* Same as for Root-knot (above).

22. *Leaf Nematode* (lupine) — See (20) Leaf Nematode under General Diseases.
23. *Seed Smut* (lupine) — See (11) Smut under General Diseases.
24. *Black Mildew* (dolichos) — See (12) Sooty Mold under General Diseases.
25. *Chlorosis* — Manganese, copper, or zinc deficiency. Have a soil test made and follow the instructions in the report.

PEACH [COMMON, CHINESE WILD or DAVID, DOUBLE (WHITE-FLOWERED, PINK-FLOWERED, RED-FLOWERED), FLOWERING], APRICOT [COMMON, DWARF FLOWERING, FLOWERING, JAPANESE], NECTARINE, ALMOND [DWARF FLOWERING (PINK and WHITE), FLOWERING, PINK, RUSSIAN], PLUM [ALLEGHENY, AMERICAN (PURPLELEAF), BEACH or BLACK, CANADA, DAMSON TYPE or BULLACE, GARDEN or PRUNE, JAPANESE, MYROBALAN or CHERRY, PACIFIC, PURPLE or ORIENTAL, WILD GOOSE, BLACKTHORN], PURPLELEAF BUSH, CHERRY-LAUREL [CAROLINA, ENGLISH], CHERRY [BESSEY (HANSSENS-BUSH or WESTERN SAND), BLACK, BITTER, BUSH, CATALINA ISLAND, CHINESE BUSH, DOUBLE-FLOWERED SOUR, DOUBLE-FLOWERED MAZZARD, FUJI, HIGAN, HOLLYLEAF, HYBRID BUSH, JAPANESE FLOWERING, EUROPEAN BIRD, NANKING or MANCHU, NADEN, NANKING BUSH, ORIENTAL FLOWERING (KWANZAN, SHIROFUGEN, AMANOOGAWA, FUGENZO, KIKU-SHIDARE, SHIROTAE OR MOUNT FUJI, TEMARI), MAHALEB or ST. LUCIE, MORELLO, PURPLELEAF SAND, SAND, SARGENT'S JAPANESE, SOUR (DWARF or PIE), SWEET or MAZZARD, WEEPING HIGAN, WILD RED or PIN, YOSHINO], ROSE TREE OF CHINA, MAYDAY-TREE, AMUR CHOKECHERRY, PURPLELEAF CHOKECHERRY (*Prunus*)

1. *Brown Rots, Twig Blights, Blossom Blights* — General and serious. Blossoms wilt, turn brown, and rot in wet weather. Leaves on twig tips suddenly wither and turn brown. Twigs may die back. Soft, brown, rotted areas in the fruit. Affected areas may later be covered by tufts of gray to tan mold. Fruits shrivel and become dry, hard, wrinkled mummies. See Figure 46D under General Diseases. *Control:* Destroy wild or neglected stone fruits and other *Prunus* species nearby. Remove and destroy blighted twigs when first found. Avoid heavy dense growth and crowding of trees. Collect and destroy rotting fruit promptly. Handle fruit carefully. Dip picked fruit in a captan solution (2 tablespoons in a gallon of water) and refrigerate promptly. Follow the regular spray program (see Table 10 in the Appendix) using captan, thiram, sulfur, or maneb. Red Gold peach; Lexington and Redbud nectarines; Hemskirke, Moorpark, Tilton, and Wenatchee apricots have resistance. Control insects (e.g., plant bugs, plum curculio, oriental fruit moth) which provide wounds through which brown rot fungi enter.
2. *Twig, Branch and Trunk Cankers, Dieback, Gummosis* — Widespread, may be serious. Discolored, slightly sunken, brownish areas on the twigs, branches, and trunk which enlarge and may girdle affected parts. Gum may exude from cankers. Buds are often killed. Twigs, branches, or entire trees, decline, wilt, and die back. See Figure 149. *Control:* Remove and burn all dead or dying twigs and limbs during late winter. Avoid excessively high fertilization, especially with nitrogen, in the fall. Protect trees against Winter Injury (see below), borers, scales, and other insects, and cultivation or mowing wounds. Destroy severely infected trees. Cut away affected bark and wood on large cankers (see page 24) during the dormant period, and paint wounds with a water-asphalt emulsion containing 5 tablespoons per gallon of Elgetol or Krenite, or use a 1:500 solution of mercuric chloride (2 tablets

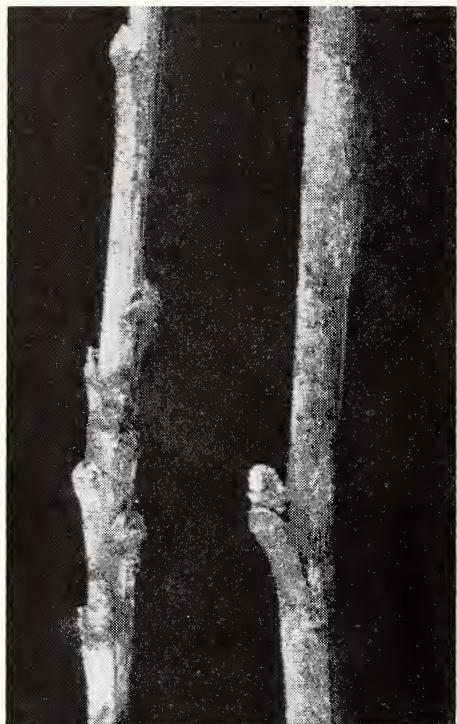


Fig. 149. Peach twig cankers.

in $\frac{1}{2}$ pint of water and $\frac{1}{2}$ pint of glycerine). Follow the recommended spray programs as for Brown Rots (above) and Scab (below). Varieties differ in resistance. Apply dichlone, zineb, or maneb before leaf fall and after harvest.

3. *Wood Rots* — Cosmopolitan. Stone fruits are very susceptible. Often follows freezing, insect damage, untreated pruning cuts, or other injury. See under Birch, and (23) Wood Rot under General Diseases. *Control:* Follow the recommended spray program in the Appendix (Table 10). Control borers by spraying the trunk and scaffold limbs with DDT. Check with your county agent or extension entomologist regarding rate to use and dates of application for your area.
4. *Leaf Curl, Witches'-broom, Plum Pockets* — General following cool, rainy weather in the spring. Unfolding leaves may become severely curled, "blistered," swollen, yellow, reddish or purplish, and leathery. Affected leaves wither and fall with a second crop of leaves forming later in the season. Severe attacks weaken trees and greatly reduce fruiting. See Figure 24 under General Diseases. On *cherries*, *plums* and *cherry-laurel* — closely grouped clusters of long, slender, irregular twigs arise near the same point on a stem (Witches'-broom). Branches may be stunted. Twigs die back. Also on *plums*, extremely large, light-colored, hollow, wrinkled fruit which drop early (Plum Pockets). Infected shoots are often distorted and swollen, later die. *Control:* Follow the spray program given in Table 10 in the Appendix. Prune out witches'-brooms. Destroy infected fruit. Maintain trees in a healthy, vigorous condition. Varieties differ in resistance. Apply a single dormant spray before buds swell in early spring using lime-sulfur (1:16), bordeaux (4-4-50), phenyl mercury, thiram, or captan. Follow the manufacturer's directions. Add a spreader-sticker to the spray to ensure wetting of the buds.

5. *Cherry Leaf Spot, Shot-hole, Yellow Leaf* — General and serious. Small, round, purplish to brown spots on the leaves which often cause severe early leaf yellowing and dropping. Spots may drop out leaving shot-holes. Fruit may fall prematurely. Repeated leaf loss weakens or kills trees. See Figure 18 under General Diseases and Figure 150. *Control:* Collect and burn fallen leaves in autumn. Follow the spray program outlined in the Appendix using captan, thiram, ferbam and glyodin, manebe, ziram, or sulfur. Cyprex (dodine) and Acti-dione are used by commercial growers and nurserymen.
6. *Black Knot* (primarily cherry, plum, Mayday-tree, and apricot) — Widespread, especially in the eastern half of the United States. Elongated, rough, black swellings on the twigs, small branches, and even the trunk. Knots are a velvety olive-green color in the spring. Gradually become hard, brittle, and black by fall. Affected parts may die back. Trees gradually die. See Figure 41 under General Diseases. *Control:* Prune or remove infected wood in late winter. Make pruning cuts at least 3 to 4 inches below any sign of obvious infection. The painting of wounds on large limbs with Acti-dione (200 parts per million) is recommended. Follow the spray program given in the Appendix. Apply a delayed dormant spray of zineb, thiram (Thylate), sulfur, or captan. Destroy wild or neglected plums and cherries.

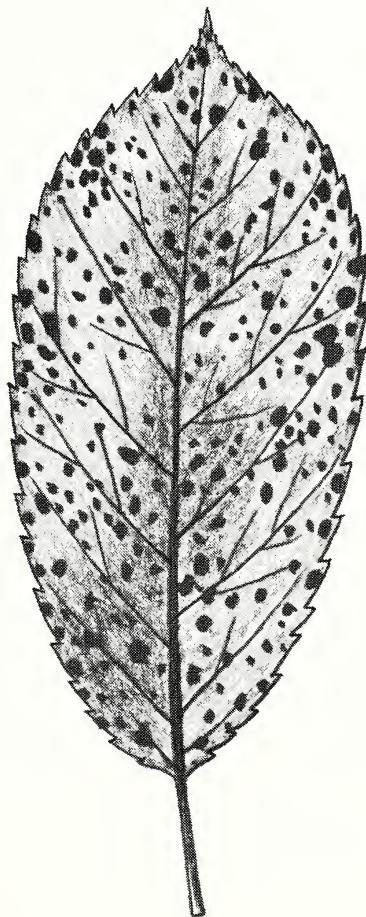


Fig. 150. Cherry leaf spot.

7. *Scab, Fruit Freckle* — General. Small, round, dark olive-green or black spots on the fruit. If numerous, fruit may crack open. Yellowish-brown blotches with gray or bluish borders develop on the twigs. Twigs may die back. Leaves are spotted a dark green to brown and drop early. Spots may first drop out leaving shot-holes. *Almond* shoots turn brown. The leaves blacken and drop early. See Figure 28B and Figure 18 Shot-hole under General Diseases. *Control:* Destroy nearby, neglected trees. A dormant spray on *peach* of phenyl mercury has given excellent control. Prune out and burn blighted twigs before growth starts. Apply sulfur, captan or ziram, at 10- to 14-day intervals, starting 10 days after bloom, following the spray program in Table 10 of the Appendix.

8. *Bacterial Cankers, Gummosis, Bacterial Spot, Shot-hole* — General and destructive. Symptoms variable. Round to elongated, water-soaked, rough, raised, thick-edged cankers on the trunk, branches, and twigs. Diseased bark is brown, gummy, and often sour-smelling. Twigs and branches are girdled and die back. Dormant buds and blossoms are blighted, and there are sunken, black spots on the fruit. Fruit may become roughened with cracked, sunken spots. Small purple, reddish, or brownish spots on the leaves later drop out leaving shot-holes. Leaves often turn yellow and drop early, weakening the trees. See Figure 18 under General Diseases. *Control:* Plant healthy, vigorous trees in fertile soil where Bacterial Canker has not been present for a number of years. Keep trees vigorous by proper fertilization, cultivation, and pruning. Apply 2 or 3 sprays of bordeaux after harvest and before the leaves fall. Follow the spray program as for Brown Rot and Scab (both above). Varieties differ in resistance (e.g., Hiley Ranger and Belle of Georgia *peaches*; *Plums* on *Myrobalan* rootstock). Check with your local nurseryman, extension horticulturist, or plant pathologist.

9. *X-Disease, Yellow-red Disease* (*peach, nectarine, cherries, plums, apricot, almond*) — Widespread. Symptoms variable due to the presence of many virus strains.

Peach — Leaves appear normal in the spring for the first 6 to 7 weeks. Then they show irregular, pale green to dark brown, or yellow-red to purplish areas which may later drop out leaving ragged shot-holes. Leaves remain pale green to yellowish-red. Tips of leaves on most varieties bend downward and the margins roll upward. Older leaves drop early, except for tufts of young leaves at the tips. Fruits shrivel and usually drop early or ripen prematurely. Bitter to the taste. Trees tend to die back gradually. X-disease may be confused with severe nitrogen deficiency and arsenic toxicity.

Sweet and Sour Cherry (little cherry, buckskin, wilt and decline) — Fruit distinctly small, poorly colored, and usually pointed. Foliage symptoms variable, depending on the virus strain, variety, rootstock, soil conditions, and other factors.

On *Mazzard* rootstocks: Trees lack vigor, are dwarfed. Foliage is somewhat sparse. Leaves are light green, later bronze-colored, may be in rosettes. Fruits on affected branches are usually small, poorly flavored, dull reddish-pink, yellow, or nearly white. Symptoms become more pronounced in succeeding years.

On *Mahaleb* rootstocks: Bearing trees often wilt and decline in vigor and fruitfulness. Die after several years. Foliage may be sparse and retarded in growth with leaves smaller, lighter green, or yellowish and narrower than normal. Leaves may drop early. Roots are killed progressively from the tips to the trunk. Young trees may wilt and die in 1 to 2 years.

Plum, Apricot — Most commercial varieties may be symptomless carriers.

Control: Destroy wild cherries, especially chokecherries, plums, peaches, and other wild *Prunus* spp. within 500 feet and preferably 300 yards or further. Destroy infected trees when first found. Plant only certified, virus-free trees from a reputable

nursery. Plant only trees which are standard, well-tested varieties in your area. Follow a complete spray program (Table 10 in the Appendix). Control insects, especially leafhoppers, which transmit the viruses, using a combination of methoxy-chlor or DDT and malathion.

There are well over 50 stone fruit diseases caused by viruses which have been reported in the United States. New ones are found every year while others are discovered as being strains of previously reported viruses. Scientists do not know at present the true status of all these viruses. Only the more important and better known diseases are discussed here. For more information read a book such as USDA Handbook No. 10, "Virus Diseases and Other Disorders with Viruslike Symptoms of Stone Fruits in North America." If you suspect a virus disease, contact your extension or state plant pathologist.

10. *Little-Peach, Little-Plum* (peach, plum, apricot) — Roughly the eastern half of the United States.

Peach — Fruit stunted, ripen later than normal. Fruit are usually insipid. Young leaves at the tips of affected branches are crinkled. Trees often stunted and bushy with pale, yellowish leaves. Leaves first darker green and more leathery than normal. Bend inward toward the shoot. Short, bushy shoots with clusters of leaves arise from the base of affected limbs.

Plums and Apricot — Symptoms on susceptible varieties are similar to peach but usually much milder. Many plums are symptomless carriers. Japanese or Oriental plums are very susceptible.

Control: Same as for X-Disease (above).

11. *Rosette* (peach, plum, apricot, almond, cherry) — Eastern half of the United States.

Peach — Symptoms variable. Young trees suddenly wilt and die. Compact rosettes, 2 to 3 inches long, composed of 200 to 400 dwarfed leaves, are conspicuous with abnormally long, straight leaves at the base of the shoots. Leaves turn yellow and drop in early summer. Trees usually bear no fruit and die within a year.

Plums — Growth is stunted. Yellowish rosettes of mottled leaves are often formed. Marianna plum appears to be immune. Japanese and Damson plums are susceptible.

Apricot — Symptoms variable. Trees markedly stunted. Leaves may have a yellowish tinge and show a mosaic mottling. Typical rosettes are formed.

Almond, Cherries — Growth is stunted. Rosettes of yellowish-green leaves are formed.

Control: Same as for X-Disease (above).

12. *Peach Yellows* (peach, nectarine, plums, apricot, almond) — General over much of the United States, especially in eastern states. Symptoms variable.

Peach, Apricot and Almond — Leaves are pale green, yellow or yellowish-bronze in color. May be mottled dark and light green. Leaves curl, roll upward and inward. Drop early. Fruit ripen prematurely, often with reddish or purple blotches. Flavor is bitter or insipid. Reddish streaks may be seen in the fruit flesh. Clusters of thin, wiry, erect shoots with narrow, yellowish, red-spotted leaves are common. Trees appear bushy and often die in 2 to 6 years. See Figure 34C under General Diseases.

Plum — Certain Japanese varieties are symptomless carriers. Other plums show typical foliage symptoms, but are often milder than on peach.

Control: Same as for X-Disease (above).

13. *Sour Cherry Yellows* (Montmorency, Early Richmond, and English Morello) — Widespread. Infects all *Prunus* spp. Symptoms variable. Leaves on sour cherry are

mottled green and yellow. Later the entire leaf usually turns yellow and drops early. Failure of fruit spur development and willowy-type growth with long bare spaces on the twigs are common symptoms. Yields may be reduced from 20 to 70 per cent. Many ornamental, wild, and sweet cherries and other *Prunus* spp. are symptomless carriers. The virus may be a strain of Peach Ringspot. *Control:* Same as for X-Disease (above). Destroy infected trees in young orchards.

14. *Ringspot Complex, Tatterleaf* — Widespread on practically all *Prunus* spp. Symptoms variable. Many plants are symptomless carriers. Caused by a complex of many virus strains.

Sweet Cherry — Pale green to yellow mottling, spots, ring, oakleaf, and brown line patterns may form on the leaves. Dead spots (which may drop out) often develop. Terminal shoot growth may die back. Symptoms tend to fade as the season progresses.

Sour Cherry — Finely etched rings or lines may form a network on the leaves. Dead spots in the leaves often drop out giving a "tatterleaf" condition. Blossoms may be distorted and often do not set fruit. Trees may have a thin appearance. Ringspot is often accompanied by Yellows (above).

Plums — Symptoms are often absent or mild. Common in Japanese and garden plums. Rings and yellowish patterns or dead flecks and spots are produced on some varieties, especially during the acute stage of the disease. Spots may turn brown and drop out leaving shot-holes and tattered leaves. See Plum Decline (below).

Almond, Apricot — Most virus strains producing symptoms cause ringspots or yellowish oakleaf patterns. These are most severe during the first year of infection.

Peach — Symptoms variable. Growth may be stunted. Twigs die back. Yellowish-green, yellow, or brown rings and spots or oakleaf patterns form on the leaves. The centers may drop out leaving shot-holes. Buds are often killed. Trees may appear to recover, show no further symptoms.

Control: Same as for X-Disease (above). Plant only standard, well-tested varieties adapted to your area. Destroy older plum trees showing evidence of decline.

15. *Plum Decline* (Line Pattern, Ringspot, Tatterleaf, Prune Dwarf) — Widespread. A virus complex which probably infects most *Prunus* spp. Symptoms variable. Foliage is discolored with spotting and localized killing (reddening, yellowing, line or oakleaf patterns, ringspots, tattered and strap leaves), plus sparse foliage, witches'-brooms, and dieback of twigs and branches. Growth is reduced. Individual trees or some plum varieties decline in vigor and productivity. Leaf spots may turn brown and drop out leaving ragged and torn leaves. Common in Japanese and garden plums. Prune Dwarf is a strain of Peach Ringspot virus. Striking, yellow to white lines and oakleaf patterns develop on the leaves of *Oriental flowering cherries*. *Control:* Plant only virus-free trees of standard, well-tested varieties from a reputable nursery. Destroy older trees which show evidence of decline. Otherwise same as for X-Disease (above).

16. *Phony Peach* (peach, plums, apricot, almond) — Southern half of the United States, especially the eastern half. Flattened, abnormally dark green leaves. Terminal leaves are close together on stunted twigs. Fruit are small and ripen early. Poor in flavor. Growth is checked and trees are dwarfed. Fruit production stops after 3 to 4 years. Twigs and branches die back. The causal virus is in practically all wild plums. *Control:* Same as for X-Disease (above). Check with your county agent or extension plant pathologist.

17. *Mosaics* (peach, nectarine, almond, apricot, plums, prune) — Southwestern half of the United States. Sweet and sour cherry and most cherry-like species are immune. Symptoms very variable due to many virus strains.

Peach — The disease proceeds through acute and chronic phases. Severely infected trees later partially recover. Leaves may be crinkled and distorted with mottled, yellowish or yellowish-green spots, blotches, and irregular patterns. Clusters of twigs at the tips of branches. Leaves are often small and bunched in rosettes. Growth is retarded. Flowers are often streaked and spotted (broken). Fruit may be misshapen, bumpy, and dwarfed with uneven color. Freestone varieties (e.g., Elberta, J. H. Hale) are most severely attacked. A few freestones, e.g., Erly-Red-Fre, Fisher, and Valiant are highly tolerant. Most clingstones (e.g., Paloro, Peak, Phillips, Sims) tolerate the virus with little damage. Check with your state or extension plant pathologist.

Apricot, Almond and Other Hosts — Symptoms variable. Wild plums are usually symptomless carriers. Leaves may be faintly mottled or sprinkled with indistinct to brilliant, lighter green spots or splotches, rings, or oakleaf patterns. Yellowish spots, stripes, and streaks may develop in the lighter green blotches. Infected fruit may be bumpy, misshapen, and worthless. Stones of *almond* and *apricot* fruit show white rings and blotches. Some *plum* varieties are symptomless carriers. Others appear to be immune.

Control: Same as for X-Disease (above). Control bud mites and dagger nematodes (*Xiphinema*) which help transmit certain viruses. Check with your extension entomologist.

18. *Apricot Ring Pox* — Western states. Yellowish rings, mottling, or irregular blotches develop on the leaves. Later the leaves may be ragged with a shot-hole appearance. Irregular, reddish-brown blotches or rings appear on the fruit which may pit the surface causing distorted, bumpy fruit. Ripe fruit often crack in the discolored areas. Many affected fruit drop early. *Control:* Same as for X-Disease (above).
19. *Cherry Rasp Leaf, Leaf Enation* — Western states. Toothlike or rasplike outgrowths (enations) protrude from the underleaf surface. Leaves may be smaller, narrower, markedly distorted, and longer than normal. Tree growth is stunted. Fruit crop is reduced. *Control:* Same as for X-Disease (above).
20. *Cherry Mottle Complex* (mild or severe mottle leaf; mild, severe and necrotic rusty mottle [Lambert mottle]) — Primarily in the Pacific Northwest. A complex of a number of virus strains. Symptoms are different depending on the variety, virus strain, and other factors.

Sweet Cherry — Leaves on one or more branches, on certain varieties, show a variable, irregular, yellowish mottling. Leaves may be twisted, wrinkled, and puckered (Mottle Leaf). Later, certain leaves may become bright yellow to red with islands of green (Rusty Mottle). These leaves drop early. Mottling of the remaining foliage becomes more pronounced. The yellowish spots and areas may become yellowish-brown or brown and dead. The foliage from a distance has a general "rusty" or bronzed appearance. Where leaf drop has been heavy, the foliage is sparse except for the branch tips. In the fall, conspicuous dark green ring and line patterns develop on a background of yellow, brown, or brilliant red (Necrotic Rusty Mottle). If severe, fruit may be small, hard, ripen late, and taste insipid. Trees may be stunted and appear rosette-like. Trees may die back and slowly decline.

Sour and Oriental Flowering Cherries — May be practically symptomless carriers or show mild symptoms as for sweet cherry.

Peach — Most varieties are symptomless. Certain varieties have leaves with striking greenish-yellow or yellow ringspots and patterns. Such leaves soon drop and the tree may appear normal.

Control: Same as for X-Disease (above).

21. *Asteroid Spot* (peach, nectarine, almond, apricot, plums) — Widespread. Small, yellow, star-shaped areas develop along the veins of nearly full grown leaves. Large,

angular blotches form along the veins on certain leaves. Leaves may then turn yellow with the flecks and splotches becoming light green. Such leaves drop early. Symptoms may only be evident during the acute stage. Apparently causes little damage. *Control:* Affected trees should be destroyed in the nursery and not used for propagating purposes. Control insects and mites by following the spray program in the Appendix (Table 10).

22. *Coryneum Blight, Twig Canker, Shot-hole* — Widespread. Most serious on peach and apricot. Small, round, reddish to purple spots on the twigs in early spring which may become brown, elongated, and slightly sunken. Twigs show gumming and dieback. Buds are darker in color and killed. Round, dark brown to reddish-brown leaf spots with dark red borders. Leaf spots may drop out leaving shot-holes. See (4) Shot-hole under General Diseases. Flowers may wither. Fruit spots are small, round, and a deep purplish-red. Later the spots become raised and roughened with the fruit cracking and exuding gum. *Control:* Follow the spray program in the Appendix. Apply one or more postharvest sprays of ziram, fixed copper, or bordeaux (5-5-50). Check with your extension plant pathologist or horticulturist.
23. *Verticillium Wilt, Blackheart Wilt* — Mostly in western states. Symptoms variable. On *peach* the leaves on certain limbs are blanched, dull, and fall in early summer. Leaves on lower branches are attacked first as the disease progresses upwards. Gray or light to dark brown streaks are evident in the sapwood of infected trunk or limbs. Trees are stunted and may die gradually over a period of years or very suddenly (especially cherries). On *cherry* the older leaves turn yellow and wilt in summer. Later the leaves turn reddish-violet with dry, curled margins and brown patches between the veins. Leaves turn yellow, quickly wilt and wither. Infected branches appear scorched with leaves remaining on the tree. Affected trees may live on for several years in a sickly condition with dead branches. Brown to black streaks in the sapwood. *Control:* Prune off and burn affected limbs at the trunk. Water and fertilize, where practical, to maintain good vigor. Destroy severely infected trees.
24. *Powdery Mildews* — General. Young leaves tend to crinkle, twist, and fold up. They are covered with white to light gray powdery patches which may later become rusty-brown in color. Mold patches also develop on the young twigs and fruit. Fruit may be misshapen and "scabby." Most serious on young, rapidly growing trees. *Control:* If severe, apply sulfur or Karathane when first seen. Repeat in the next 2 regular sprays. Also apply a postharvest spray on *cherries* and *apricots* if mildew starts to build up. Varieties differ in resistance.
25. *Crown Gall, Hairy Root* — General. Small to large, gall-like overgrowths on the roots and crown. Infected trees lack vigor and may die. Japanese apricot (*P. mume*) is resistant. *Control:* Plant disease-free nursery stock in soil which has not grown crown gall-infected plants for at least 3 years. Avoid wounding trees near the soil line. If galls are found on trees and disease has not progressed too far, paint the entire, intact gall and not more than $\frac{1}{2}$ inch beyond the gall, with the following mixture: To crystalline streptomycin (2,000 parts per million) or Terramycin (200 parts per million) dissolved in a small amount of water (19 per cent), add 20 per cent iso-amyl gradually, followed by kerosene (80 per cent), melted lanolin ($\frac{1}{2}$ per cent), and Vaseline ($\frac{1}{2}$ per cent). Properly prepared, this mixture will be clear or slightly opalescent. Shake the mixture before using. Nurserymen soak plants for 10 to 30 minutes in Terramycin or Agrimycin 100 before planting.
26. *Rusts* — General, especially in southern states. Small yellow spots on the upper leaf surface which become purplish or bronze in color. Leaves may drop early. Small, reddish, reddish-brown, dark brown or black dusty pustules form on the under-

leaf surface. Round, sunken, green spots may develop on *peach* fruit. *Control:* Follow the spray program in the Appendix. Add zineb, ferbam, or sulfur to several consecutive sprays starting with the second cover. Some varieties may be susceptible to zineb injury. Destroy anemones, buttercup, hepatica, and meadow-rue, the alternate hosts.

27. *Root Rots, Crown Canker* — Cosmopolitan. Trees lack vigor. Gradually die. Foliage remains stunted and sparse. Leaves often turn yellow and drop early. Toadstools may be evident at the base of a dying tree. Often in clusters. Usually associated with nematodes. *Control:* See under Apple, and Figure 47B under General Diseases. Do not replant in the same soil without first fumigating with MC-2, or D-D. See pages 440-44 in the Appendix. Grow apricot on Myrobalan rootstock which is resistant to Armillaria Root Rot. Resistant rootstocks are also available for plums.
28. *Root-knot* — Common in southern states, especially on sandy soils. Heavily infested trees are stunted, with light colored foliage. Trees gradually weaken due to small spindle-shaped or irregular "knots" on the roots. Fruiting is reduced. *Control:* Grow nematode-free, resistant rootstocks in soil which was fumigated before planting. Check with your nurseryman or extension plant pathologist. Nemagon and Fumazone have been used successfully around living trees. Follow the manufacturer's directions.
29. *Other Root-feeding Nematodes* (dagger, lance, needle, pin, ring, root-lesion, sheath, stem, sting, stubby-root, stunt or stylet) — General in the United States. Trees often stunted. Make poor growth. Do not respond normally to water and fertilization. Fruit production is decreased. Twigs and branches may die back due to small feeding roots being killed. This may result in small witches'-brooms, "brushes" of stubby roots, and brown rootlets. *Control:* Same as for Root-knot (above).
30. *Minor Leaf Spots and Blotches, Leaf Blight, Shot-hole* — General. Spots of various sizes, shapes, and colors on the leaves. Spots may later drop out. Spots often occur on the twigs. *Control:* Same as for Brown Rots (above). Fertilize and prune trees to maintain vigor.
31. *Winter Injury* (especially peach) — Twigs, limbs, or even whole trees may die due to freezing temperatures and low soil moisture. Affected wood is often dark. Foliage is off-color. Trees lack vigor. *Control:* Grow peaches where adapted. For a list of hardy varieties for your area check with local growers, your county agent, or your extension horticulturist. Varieties differ greatly in winter hardiness.
32. *Fruit Rots, Fly Speck* — Cosmopolitan. See under Apple, and Brown Rots (above). Tan, black, green, pink, bluish-green, or brown mold may grow on rotting fruit. *Control:* Same as for Brown Rots (above).
33. *Sooty Mold* — Cosmopolitan. See under Apple. *Control:* Follow the recommended spray program in the Appendix (Table 10).
34. *Chlorosis, Little Leaf, Mottle Leaf* — Leaves often pale and small. Yellowing varies from a complete lack of green color to light, yellowish-green areas between the veins. Veins usually remain green. Growth may be stunted and rosette-like (zinc deficiency). Symptoms may appear first at the tips of the growing shoots where the leaves are yellowish (iron deficiency). Leaves may drop beginning with those at the bases of the shoots and continuing out the shoots. If severe, twigs die back. This may be due to a lack of or unavailability of iron, manganese, magnesium, or zinc. *Control:* See under Maple for iron deficiency and under Walnut to control zinc deficiency. Have the soil tested. Check with a local grower, your county agent, or your extension horticulturist. To correct manganese and magnesium deficiency check with your extension horticulturist.

35. *Wet Feet* — Trees growing in excessively wet soils with a high water table are stunted with sparse foliage composed of dwarfed leaves, dead twigs, and branches. Leaves may turn yellow and drop early. Roots die back. Symptoms vary with the height and persistence of the high water level in the soil. *Control:* Drain the soil (page 25) or replant in a drier spot.
36. *Fire Blight* (almond, apricot, cherry, cherry-laurel, flowering cherry, plums) — See under Apple, and (24) Fire Blight under General Diseases.
37. *Thread Blight* — Southeastern states. See under Walnut.
38. *Felt Fungus* — Southern states on neglected trees. See under Hackberry. *Control:* Follow the recommended spray program (Table 10 in the Appendix).
39. *Mistletoe* — See (39) Mistletoe under General Diseases.

PEACH BELLS — See Bellflower

PEANUT (*Arachis*)

1. *Southern Blight, Stem Rots, White Mold, Root Rots or Soil Rot* — Widespread in warm, moist weather. Entire plant or certain branches may wilt, wither, and die from a rotting of the lower stem, crown, and roots. Fruit stems (pegs) often decay. A white mold often occurs on infected parts under damp conditions. *Control:* Carefully dig up and burn infected plants. Cultivate shallowly and avoid throwing any soil on the crowns and lateral branches. Apply Terraclor (PCNB) as a dust or drench to the soil following the manufacturer's directions. Turn all plant debris under deeply (at least 4 inches) and cleanly several months before planting. Control Leaf Spots. Keep down weeds. Three-year rotation. If using Terraclor, do not feed the vines as hay to livestock.
2. *Leaf Spots, Leaf Mold* — General. Tan, brown, or black flecks, spots, or blotches on the leaves, often with light-colored margins. Elongated spots may occur on the petioles, stems, and pegs. Infected leaves usually turn yellow and drop early, reducing the yield of nuts. *Control:* Apply sulfur, sulfur-copper mixture, zineb, or maneb three or four times at 10- to 14-day intervals. Start when the first spots appear on the older leaves. Rotate.
3. *Seed Rot, Seedling Blight* — Seeds rot. Stand is thin. Seedlings are killed or weakened. *Control:* Plant high-quality, crack-free seed treated with thiram, Panogen, Ceresan, or chloranil. Plant in well-prepared soil which is 70° F. or higher. Avoid deep planting.
4. *Nematode Injury* — Plants may be stunted with yellowish-green foliage. Tend to wilt during midday. Roots, fruit stems (pegs), and fruit may have galls (Root-knot) or enlarged tap roots with a few short, stubby lateral roots (Sting Nematode). Plants affected with meadow or root-lesion nematode have small brownish to black areas on the shell and lateral roots. Other nematodes include dagger, lance, pin, reniform, ring, spiral, stylet or stunt, and stubby-root. *Control:* Three-year rotation. Fumigate with D-D, DBCP (Nemagon or Fumazone), Telone, or EDB about 3 weeks before planting, following the manufacturer's directions. Do not feed vines grown on fumigated soil to dairy animals or to animals to be slaughtered later for meat.
5. *Pod and Kernel Decays, Seed Molds, Concealed Damage* — Cosmopolitan. Entire pod or kernel may become shriveled with the seed blackened and oily. Black, blue-green, green, white, or tan mold may grow on the pods and nuts. Pods and nuts may appear normal while nuts have an internal decay (Concealed Damage). *Control:* Follow the best cultural practices. See USDA Farmers' Bulletin No. 2063, *Growing Peanuts*. Apply gypsum (400 pounds per acre or about 10 pounds per 1,000 square feet), to plants after blooms appear. Apply in a wide band over the

row for *bunch* peanuts and broadcast evenly for *runner* varieties. Keep plants growing vigorously until harvest. Control Leaf Spots, Stem Rot, and Nematodes (all above) and control leaf-feeding insects with DDT or methoxychlor. Harvest when the crop is mature (brown spots on the inside of the pods and a red color of the nut skin). Allow vines to wilt thoroughly before curing artificially for several weeks at 90° F. or above on slats or stack poles. Hold vines at least 12 inches above the ground. Cover while curing to reduce weather and bird damage. Bunch and Spanish varieties are less subject to pod and nut decays than runner varieties.

6. *Rust* — Uncommon. Southern states. Small, reddish-brown, dusty pustules on the leaves. *Control*: If severe enough, same as for Leaf Spots (above).
7. *Bacterial Wilt* — Uncommon. Southeastern states. See (15C) Bacterial Wilt under General Diseases. Peanut is quite resistant.
8. *Verticillium Wilt* — New Mexico. Leaflets turn yellow, wither, and drop prematurely. Internal brown discoloration of the stem at or below the soil line. *Control*: See (15B) Verticillium Wilt under General Diseases. Bunch types are more resistant than Valencia and Spanish types.
9. *Mosaic, Stunt* — Uncommon. See (16) Mosaic under General Diseases.
10. *Chlorosis, Manganese Deficiency* — Occurs in neutral and alkaline soils. Plants are stunted. Leaves are yellowish between the veins. *Control*: Maintain the soil reaction (pH) between 5.7 and 6.2. Apply manganese sulfate to the soil with acid-forming fertilizers. On very acid soils (below pH 5.7) apply gypsum. See under Pod and Kernel Decays (above).
11. *Hopperburn* — Tips and margins of leaves are scorched. Leaves turn yellow. Plants are dwarfed. Yield of nuts and forage is reduced. *Control*: Apply DDT with Leaf Spot dusts or sprays to control leafhoppers.
12. *Thrips Injury* — Seedling buds and leaves may be blackened. Leaflets are puckered and irregularly shaped with round to irregular, white spots on the surface. Seedling growth is delayed 2 to 3 weeks. Injury is most severe in dry weather. *Control*: Apply DDT when injury is first noticed. Repeat 7 to 10 days later.

PEAR — See Apple

PEARLEVERLASTING — See Chrysanthemum

PEA-SHRUB, PEA-TREE — See Honeylocust

PECAN — See Walnut

PELARGONIUM — See Geranium

PELLAEA — See Ferns

PENSTEMON — See Snapdragon

PEONY — See Delphinium

PEPEROMIA

1. *Corky Scab* — Indoor problem. Raised, copper-colored to dark, scablike growth on the underleaf surface. *Control*: Maintain as uniform a soil moisture supply as possible during moist, overcast weather. Increase air circulation.
2. *Ringspot* — Distorted leaves showing zoned, yellowish or brown rings. Rings may fuse together forming irregular patterns. Leaves may be markedly cupped, curled, or twisted. Plants may be stunted. *Control*: Destroy infected plants. Take cuttings only from vigorous, virus-free plants. Root in a sterile medium. Control insects with malathion sprays.

3. *Leaf Spots, Anthracnose* — See under Calla.
4. *Stem and Root Rots, Cutting Rots* — Plants stunted, gradually wither and die from a rotting of the stem at the soil line or below. May be associated with nematodes (e.g., burrowing, root-lesion, spiral). Plant in well-drained soil which is clean or sterilized (pages 437-44). Avoid overwatering.

PEPPER — See Tomato

PEPPERCARBON — See Sweet-pepperbush

PEPPERGRASS — See Cabbage

PEPPERMINT — See Salvia

PEPPERTREE — See Sumac

PEPPERVINE — See Grape

PERENNIAL PEA — See Pea

PERIWINKLE — See Vinca

PERSEA — See Avocado

PERUNKILA — See Oleander

**PERSIMMON [AMERICAN or COMMON, JAPANESE, TEXAS or BLACK]
(*Diospyros*)**

1. *Cephalosporium Wilt* — Formerly common in the southern states on American or common persimmon. Leaves in the tops of trees suddenly turn yellow and wilt. Leaves drop later in the summer. Trees may be completely defoliated. Brownish-black streaks appear just under the bark when infected wood is cut. Affected trees soon die. *Control:* Japanese persimmons appear resistant.
2. *Wood Rots* — See under Birch, and (23) Wood Rot under General Diseases.
3. *Twig Blights, Branch Canker, Dieback* — See under Apple and Elm.
4. *Leaf Spots, Leaf Blotch, Tar Spot, Scab, Anthracnose* — Spots and blotches of various colors, sizes, and shapes on the leaves. Affected leaves may wither and drop early. Certain organisms may also cause spotting of the fruit. *Control:* If serious enough, collect and burn fallen leaves. Spray as for Anthracnose of Maple or use ziram.
5. *Crown Gall* — See under Apple, and (30) Crown Gall under General Diseases.
6. *Root Rots* — Trees stunted and sickly with yellowish leaves. Tops die back. Roots discolored. See under Apple, and (34) Root Rot under General Diseases. May be associated with root-feeding nematodes (e.g., burrowing, citrus, stubby-root, *trophotylenchulus*).
7. *Powdery Mildew* — See under Birch, and (7) Powdery Mildew under General Diseases.
8. *Fruit Spots or Rots, Fly Speck* — Rot spots of various sizes and colors on the fruit. May be covered with a black, blue, or gray mold in damp weather. Rots may develop in storage. *Control:* Check with your extension horticulturist, your extension plant pathologist, or a local grower.
9. *Root-knot* — See under Peach, and (37) Root-knot under General Diseases.
10. *Verticillium Wilt* — See (15B) Verticillium Wilt under General Diseases.
11. *Thread Blight* — Southeastern states. See under Walnut.
12. *Sooty Blotch* — See under Apple, and (12) Sooty Mold under General Diseases.
13. *Mistletoe* — See (39) Mistletoe under General Diseases.

PETROSELINUM — See Celery**PE-TSAI — See Cabbage****PETUNIA — See Tomato****PHACELIA, SCORPIONWEED, CALIFORNIA-BLUEBELL (*Phacelia*);
BABY-BLUE-EYES (*Nemophila*); ROMANZOFFIA**

1. *Leaf Spots* — Leaves variously spotted following rainy periods. *Control:* Pick off and burn spotted leaves. If needed, spray several times, 10 days apart, starting when the first spots are evident. Use zineb, captan, or maneb.
2. *Powdery Mildew* (*nemophila*, *phacelia*) — Grayish-white, powdery mold on foliage. *Control:* Apply sulfur or Karathane twice, 10 days apart.
3. *Rusts* (*phacelia*, *romanzoffia*) — Yellow-orange, reddish-brown, or black powdery pustules on the leaves. Alternate hosts: wild grasses, or none. *Control:* Same as for Leaf Spots (above). Start spraying about 2 weeks before rust normally appears.
4. *Mosaic* (*phacelia*) — Widespread. Leaves mottled light and dark green. Often malformed and distorted. Broad green bands develop along the leaf veins. *Control:* Keep down weeds. Destroy infected plants when first found. Control aphids which transmit the virus by spraying weekly with malathion or lindane.
5. *Curly-top* (*phacelia*) — Western states. See (19) Curly-top under General Diseases.

PHALAENOPSIS — See Orchids**PHASEOLUS — See Bean****PHILADELPHUS — See Hydrangea****PHILIBERTIA — See Butterflyweed****PHILODENDRON — See Calla****PHLOX [ANNUAL, CREEPING, DWARF, GROUND- or MOSS-PINK, WILD-SWEET-WILLIAM, HARDY or PERENNIAL, MEADOW, and THICK-LEAF]
(*Phlox*); COLLOMIA; BLUE GILIA, SKYROCKET, TREE CYPRESS (*Gilia*);
JACOBS-LADDER or GREEK VALERIAN (*Polemonium*); POLYGALA**

1. *Powdery Mildews* — General, especially where plants are shaded or crowded. Whitish, powdery mold patches on the upperside of leaves and stems from midsummer on. Leaves may shrivel and drop early. See Figure 21D under General Diseases. *Control:* Space plants. Cut and burn all tops in the fall. Apply sulfur, Karathane, phaltan, or Acti-dione when mildew is first noticed. Repeat at 7- to 10-day intervals following the manufacturer's directions. Phlox varieties differ in resistance.
2. *Leaf Spots, Blights* — General. Spots on the leaves of various sizes, shapes, and colors. Spots may run together forming irregular blotches. Usually occur first on the lower leaves which wither and dry up. Plants are stunted. Bloom is reduced. See Figure 17D under General Diseases. *Control:* Destroy tops in the fall. Apply a complete fertilizer in the spring. Plant disease-free seed treated with thiram, captan, or chloranil. Water during dry periods. Divide old clumps. Keep down weeds. Apply sulfur, zineb, ferbam, or fixed copper at 10-day intervals, starting a week before leaf spot is expected. Control insects and mites, using malathion. Phlox varieties differ in susceptibility.

3. *Phlox Leaf Drop, Blight* — Leaves turn brown and die progressively upwards from the base of the stem. Shoots may die. Most severe on older clumps where soil nutrients are exhausted. Varieties differ in susceptibility. *Control:* Same as for Leaf Spots (above).
4. *Stem and Crown Rots, Southern Blight, Stem Blight or Canker, Root Rots* — General. Seedlings or older plants are often stunted, wilt, wither, and may collapse. Base of stem and roots are rotted. May be covered with a cottony mold. *Control:* Carefully dig up and destroy infected plants. Space plants. Three- or 4-year rotation. Avoid overwatering, overcrowding, and planting in heavy, poorly drained soil. When rot first strikes, soak base of plants with a 1:1,000 solution of mercuric chloride. Repeat in 2 weeks. Hill up fresh soil around infected plants.
5. *Mosaic* — Widespread on phlox. Leaves are mottled light and dark green with some yellowing. *Control:* Destroy infected plants. Keep down weeds. Spray at weekly intervals with malathion to control aphids.
6. *Leaf and Stem Nematodes* (collomia, ground- or moss-pink, phlox) — Plants may be stunted. Leaves are spindling, thickened, crinkled, or curled. Stems may be swollen or cracked and bent sideways near the tips. Buds swollen. Shoots are stunted, distorted, may die before producing flowers. Blotches on the leaves are caused by the Leaf Nematode. See under Chrysanthemum, and (20) Leaf Nematode under General Diseases. *Control:* Dig up and burn infested clumps when first found. Rotate plantings. Plant healthy seed or plants in soil fumigated with EDB, D-D, chloropicrin, or other fumigant. See "Soil Treatment Methods and Materials" in the Appendix. Varieties differ greatly in susceptibility.
7. *Aster Yellows* — Flower petals often show white streaks and vein-banding. Clusters of flowers or individual petals may turn into green leafy structures. Successive flowers may develop from the ovaries. *Control:* Destroy infected plants. Keep down weeds. Spray weekly with a mixture of DDT and malathion. This controls the leafhoppers which transmit the virus.
8. *Fusarium and Verticillium Wilts* — Stems on one side of the plant show wilting of the lower leaves. Wilt later progresses gradually up the stem. *Control:* Dig up and destroy infected plants. Rotate. Plant in well-drained soil.
9. *Downy Mildew* — See (6) Downy Mildew under General Diseases. *Control:* Spray as for Leaf Spots (above).
10. *Rusts* — Yellow, orange, reddish-brown, or black pustules on the leaves. *Control:* Pick off and burn rusted leaves. Spray as for Leaf Spots (above). Destroy tops in the fall.
11. *Root-Knot* — See (37) Root-knot under General Diseases.
12. *Fasciation, Leafy Gall* (phlox) — Uncommon. See under Pea, and (20) Leafy Gall under General Diseases.
13. *Gray-mold Blight* — See under Chrysanthemum, and (5) Botrytis Blight under General Diseases.
14. *Crown Gall* (phlox) — Uncommon. See (30) Crown Gall under General Diseases.
15. *Streak* (phlox) — Streaks develop in leaves and stems. Leaf veins turn yellow. Later the petioles and leaves wither. *Control:* Dig up and burn infected plants.
16. *Chlorosis* — See under Rose.

PHOENIX — See Palms**PHOENIX-TREE, CHINESE PARASOLTREE (*Firmiana*), CALIFORNIA FREMONTIA, FLANNEL-BUSH (*Fremontia*)**

1. *Twig Canker, Coral Spot* — Twigs and branches die back. Bark surface is cankered. May be covered with tiny, bright, coral-red "cushions." *Control:* Prune off dead and blighted twigs. Keep trees growing vigorously by fertilizing and watering during summer droughts.
2. *Web Blight* — Southeastern states. See under Bean.
3. *Root Rot* — See (34) Root Rot under General Diseases.
4. *Verticillium Wilt* (*fremontia*) — See (15B) Verticillium Wilt Under General Diseases.
5. *Collar Rot, Stem Girdle* (*fremontia*) — See under Dogwood.
6. *Leaf Spot* — Unimportant. Leaves spotted. *Control:* Not necessary.

PHOTINIA — See Apple**PHYLA — See Lantana****PHYSALIS — See Tomato****PHYSOCARPUS — See Ninebark****PHYSOSTEGIA — See Salvia****PICEA — See Pine****PIERIS — See Andromeda****PIGGY-BACK PLANT, PICK-A-BACK PLANT (*Tolmiea*)**

1. *Powdery Mildew* — Grayish-white mold patches on the foliage. *Control:* Spray twice, 10 days apart, using sulfur or Karathane.

PILEA — See Artillery-plant**PIMPERNEL — See Primrose****PIMPINELLA — See Celery****PINCUSHION FLOWER — See Scabiosa**

PINE [ALEppo, AUSTRIAN, BLACK, CANARY, COMPACT MOUNTAIN, COLORADO, COULTER, HIMALAYAN, JACK or NORWAY, JAPANESE (BLACK, RED, UMBRELLA, WHITE), KOREAN, LACEBARK, LIMBER, MACEDONIAN, MUGHO, MOUNTAIN, PINYON, PITCH, PONDEROSA, RED, SCOTS or SCOTCH (PYRAMIDAL SCOTS), SWISS MOUNTAIN, SWISS STONE, VIRGINIA or SCRUB, WESTERN YELLOW, WHITE (DWARF PYRAMIDAL, UMBRELLA)] (*Pinus*); **FIR** [ALPINE, BALSAM or BALM OF GILEAD, CALIFORNIA RED, CILICIAN, COLORADO or WHITE, CONICAL, CORKBARK, GREEK, LOWLAND WHITE, MOMI, NIKKO, NOBLE, NORDMANN, NORMAN or CAUCASIAN, PACIFIC SILVER, ROCKY MOUNTAIN, SHASTA RED, SILVER, SOUTHERN BALSAM or FRASER, SPANISH, VEITCH] (*Abies*); **CEDAR** [ATLAS or ALGERIAN, BLUE ATLAS, DEODAR, CEDAR OF LEBANON, WEEPING BLUE ATLAS, WEEPING LEBANON] (*Cedrus*); **SPRUCE** [BLACK, BLACK HILLS, BLUE, COLORADO (BLUE, WEEPING BLUE), DRAGON, DWARF ALBERTA, DWARF ORIENTAL, DWARF SERBIAN, ENGELMANN, HEDGE-HOG, KOSTER'S, NORWAY (YELLOW, WEEPING), ORIENTAL, RED, SERBIAN, SITKA, TIGERTAIL, WESTERN WHITE, WHITE or CANADIAN, WILSON] (*Picea*); **DOUGLAS-FIR** [ROCKY MOUNTAIN, WEEPING] (*Pseudotsuga*); **UMBRELLA-PINE** (*Sciadopitys*); **REDWOOD**, GIANT SEQUOIA (*Sequoia*); **BALDCYPRESS** (*Taxodium*); **HEMLOCK** [CANADA or COMMON (DARK GREEN, WEEPING), CAROLINA, JAPANESE, MOUNTAIN, SIEBOLD, WESTERN] (*Tsuga*)

1. *Needle Casts, Leaf Blights, Tar Spots, Twig Blights* — General, may be serious. Irregular, yellow, orange, reddish-brown, brown or black specks, spots, or bands on the needles. Needles later turn yellow, red, or brown, often from the tip downward, and drop prematurely. Twigs are stunted and may die back. Foliage

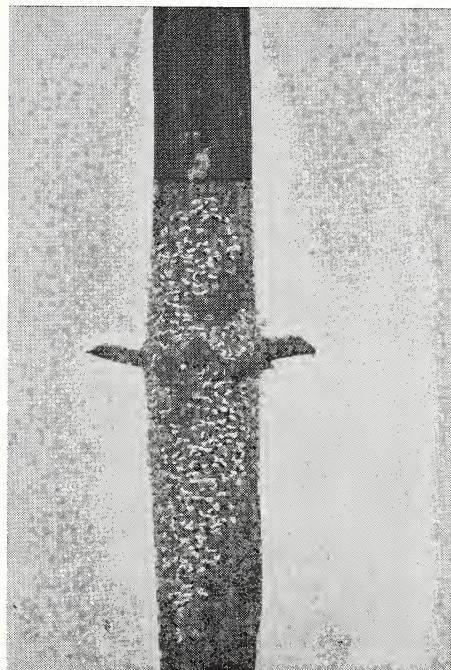


Fig. 151. Pine needle blight.

- is sparse and trees appear sickly. See Figure 151. Growth slows down. The lower branches are usually attacked first. Trees may eventually die. *Control*: Collect and burn fallen needles. Prune out and burn dead twigs. Water during droughts. Fertilize trees in fall or early spring. Where practical, spray new growth when the "candles" are $\frac{1}{4}$ emerged. Repeat 2, 4, and 6 weeks later, using zineb, maneb, phenyl mercury, fixed copper, or bordeaux mixture (4-4-50) plus wetting agent.
2. *Shoot or Tip Blights* — New growth stunted. Wilts. Progressively turns pale green, then yellow, finally brown, and dies back. Twigs may die. Resembles spring frost injury. If severe, trees may be browned, stunted, and disfigured. *Control*: Same as for Needle Casts (above).
 3. *Wood and Heart Rots, Trunk Rot, Butt Rot* — Cosmopolitan. See under Birch, and (23) Wood Rot under General Diseases. "Pecky cypress" is actually wood affected with a wood rot known as Brown Pocket Heart Rot. Wood-rotting fungi frequently enter through wounds made by insects.

4. *Twig, Branch, and Trunk Cankers* — General. Oval to elongated, sunken or swollen, often flattened cankers with or without definite margins. Often found near branch stubs. Twigs and branches may be girdled and killed. Cankers later become rough and crack open. Resin streaks may flow from the wounds. Weakened trees, growing on a poor site, are most susceptible to infection. The lower branches often die first. *Control:* Remove and burn dead and dying branches. Avoid bark injuries. Paint over wounds promptly with tree wound dressing (page 25). Increase vigor by fertilizing and watering. Spray as for Needle Casts (above).
5. *Cytospora Canker, Twig Blight* (primarily spruce, Douglas-fir, and hemlock) — Widespread and serious, especially on Norway and Colorado spruces. Koster's blue spruce and Douglas-fir are more resistant. Lower limbs turn brown and die back to the trunk. Later the disease progresses upward. Tufts of needles at the branch tips turn light gray or brown and die first. Large amounts of whitish resin are common on the dark bark of dying branches. More prevalent on trees older than 15 years. *Control:* None very satisfactory. Cut and burn dying branches and the two apparently healthy ones just above as soon as found. Do not prune when foliage is wet. Swab tools with 70 per cent denatured alcohol between cuts. Avoid injuring the bark. Otherwise same as for Twig, Branch, and Trunk Cankers (above).
6. *White Pine Blister Rust* (5-needle pines) — Widespread and serious, especially in forest plantings. Small, dark, oozing blisters on the twigs, branches, and trunk. Blister-cankers later form larger, bright orange to pale yellow, dusty pustules. See Figure 152. Disease spreads rapidly up and down the tree killing the branches.

Fig. 152. White pine blister rust. (Iowa State University photo)



Entire tree may die if the trunk is attacked and girdled. Alternate hosts include rust-spreading currants and gooseberries and *Grossularia*. *Control:* Promptly cut and burn affected parts. Make cuts at least 4 inches below the discolored bark at the edges of the canker. Increase this distance to 6 inches in the spring and early summer. Plant only currants and gooseberries from a reputable nursery. These will not become infected by the blister rust fungus. Destroy wild currants or gooseberries which are rust-infected. Paint or spray pines with a special formulation of Acti-dione in fuel oil. Follow the manufacturer's directions.

7. *Needle and Cone Rusts* — Widespread but not serious. Whitish, yellow, reddish, or bright orange to brown, dusty pustules on the needles and cones. Needles often

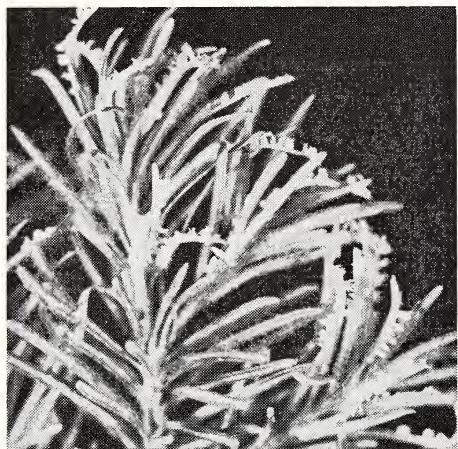


Fig. 153. Needle rust of spruce.

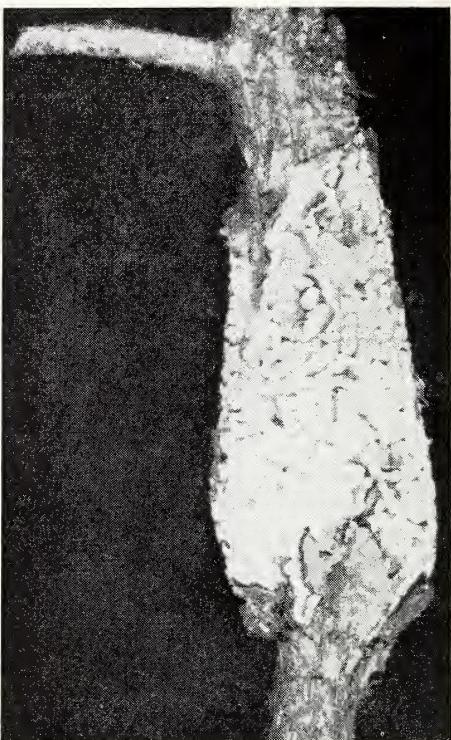


Fig. 154. Fusiform gall rust of pine. (Courtesy Dr. V. H. Young)

turn yellow and may drop early. Most serious on young trees. May cause some distortion, dwarfing, and even death. See Figure 153. Alternate hosts include amsonia, apple, arborvitae, asters, azalea, blueberry, campanula, creeping snowberry, crowberry, erigeron, ferns, fireweed, flowering currant, gayfeather, goldenrod, gooseberry, gumweed, heliopsis, huckleberry, hydrangea, iron weed, Jerusalem-artichoke, Labrador-tea, leatherleaf or cassandra, loosestrife, marigold, morning-glory, mountain-ash, poplars, pyrola, raspberry, rhododendron, silphium, sow-thistle, sunflower, sweetpotato, tickseed, venus-lookingglass, willow, and wood-nymph. *Control:* If serious enough, spray as for Needle Casts (above) or use ferbam or sulfur. If practical, destroy nearby, worthless, alternate hosts (e.g., goldenrod, sowthistle).

8. *Gall Rusts* — More or less spherical, pear-shaped, or spindle-shaped galls (or large burls) on the branches or trunk up to a foot or more in diameter. Witches'-brooms

or deep cankers may form instead. Foliage beyond the canker or gall is discolored. Later wilts and dies. Seedlings and saplings are frequently killed. Galls appear whitish or yellow-orange and blister-like in the spring. See Figure 154. Oaks, chestnut, sweetfern, sweetgale, Indian paintbrush, peregrina, lousewort, bastard toad-flax, birds-beak, owlclover, Pacific waxmyrtle, cow-wheat, and myriagale are the alternate hosts. *Control:* Where practical, remove the galls by annual pruning. Destroy nearby worthless oaks and other alternate hosts. Plant rust-free nursery stock. Spray as for Needle Casts (above) or use ferbam or ziram (5 tablespoons per gallon of water).

9. *Rust Witches'-brooms* (fir, spruce) — Widespread. Young twigs are stunted from clusters of compact, broomlike growths with close clusters of dwarfed leaves. Needles may turn yellow and drop early leaving the bare witches'-brooms. The bark may show gall-like swellings. Orange blisters appear on the yellowish leaves later in the summer. *Control:* Where feasible, prune out and burn witches'-brooms. Destroy the alternate hosts of fir rust: chickweed and stickwort (*Stellaria*).
10. *Seedling Blights, Damping-off, Root Rots* — Cosmopolitan. Seedlings in nurseries wither, turn brown, and die. Roots decay. Plants are easily pulled up. Often associated with root-feeding nematodes (see below). *Control:* Treat seed with thiram, dichlone, or captan and plant in well-drained soil which has been treated with heat or chemicals. See pages 437-44 in the Appendix. Use a treatment which will kill weed seeds in the soil plus fungi and nematodes. Apply soil drenches of thiram, zineb, captan, maneb, or ferbam at monthly intervals from May to September. Use about 2 tablespoons of chemical per gallon of water. Apply about $\frac{1}{2}$ pint of solution per square foot. Keep down weeds. Avoid overwatering.
11. *Sooty Molds, Black Mildew* — Widespread. Black mold growth on the needles and twigs. Often follows insect attacks. *Control:* Keep aphids, scales, and other insects in check by malathion sprays.
12. *Root Rots* — Widespread. Trees decline in vigor. Foliage is thin and sickly. Needles turn yellow, wither, and drop early. Probably associated with root-feeding nematodes. See under Apple, and (34) Root Rot under General Diseases. Control root-feeding insects and nematodes. Check with your extension entomologist.
13. *Root-feeding Nematodes* (awl, cyst, cystoid, dagger, lance, needle, pin, ring, root-knot, root-lesion, sheath, spear, spiral, sting, stubby-root, stylet or stunt) — Plants grow more slowly. Tend to have poor color. Roots may die back. See under Root Rots (above). Affected seedlings are stunted with smaller needles and poor color. *Control:* See under Peach, and (37) Root-knot under General Diseases.
14. *Witches'-broom, Dwarf and American Mistletoes* — Primarily in western states. See Figure 52B, and (39) Mistletoe under General Diseases.
15. *Dieback* — Tops of large trees turn yellow and die back, presumably because of poor growing conditions. Foliage thins. Leader growth and needles are stunted. *Control:* Water and fertilize trees to maintain good vigor. Mulch and water plants in late fall. Grow adapted species and varieties. Control insects with malathion sprays. Plant in well-drained soil.
16. *Winter Injury, Needle Scorch* — Last year's needles turn reddish-brown and die from the tip down, usually more on exposed branches. Needles may fall during late spring or summer. Do not confuse with normal browning and falling which occurs late in the fall to the older needles or to those nearest the trunk. *Control:* Water plants late in the fall and during droughts. Mulch plants to prevent deep freezing plus alternate freezing and thawing (page 29). Plant adapted and recommended species in a location protected from warm, dry, winter winds.

17. *Sunscorch and Wind Damage* (primarily fir, hemlock, pine, and spruce) — Foliage appears scorched. Needles dry out and turn brown from the tip down. Tips of hemlock branches die back. Injury follows dry, windy weather with temperatures of 95° F. or higher. Severe winter weather and mite injury may cause similar symptoms. *Control:* Keep trees well watered during hot, dry periods. Plant in protected locations. Control mites using malathion.
18. *Douglas-fir Bacterial Gall* — California. Round, rough galls, up to several inches in diameter on the upper branches, twigs, or leader. Top may die. *Control:* Prune out galls. Control aphids, which spread the causal bacteria, with malathion sprays.
19. *Crown Gall* (redwood) — See (30) Crown Gall under General Diseases.
20. *Brown Felt Blights, Snow Blights* — Foliage is killed under the snow. Needles are brown and covered with white fungus growth as the snow melts (Snow Blight) or a dense brown to almost black, feltlike growth (Brown Felt Blight). Black specks later appear on the needles. *Control:* Spray nursery beds and lowest branches on other trees with lime-sulfur (1:8) in late fall.

PINK ALMOND — See Peach

PINKS — See Carnation

PINXTERBLOOM — See Rhododendron

PIQUERIA — See Chrysanthemum

PISTACHE, PISTACHIO (*Pistacia*) — See Sumac

PISUM — See Pea

PITTOSPORUM [CAPE, JAPANESE] (*Pittosporum*)

1. *Leaf Spots* — Small, angular, yellow to dull brown spots on the leaves. Leaves may turn yellow and drop early. *Control:* If practical, pick off and burn spotted leaves. Apply zineb, maneb, or fixed copper sprays at about 2-week intervals during rainy periods.
2. *Stem Rot, Southern Blight, Foot Rot* — Plants wilt, wither, and die from a rotting of the stems near the soil line. Affected areas may be covered with white mold growth in damp weather. Roots may decay. *Control:* Plant in well-drained soil. Avoid wounding the bark. Keep trees growing vigorously. Avoid overwatering. Commercial nurserymen treat planting beds with steam or chemicals. See pages 437-44 in the Appendix. Post-planting treatments may be beneficial. See under Cabbage Wirestem.
3. *Mosaic* — See (16) Mosaic under General Diseases.
4. *Verticillium Wilt* — See under Maple, and (15B) Verticillium Wilt under General Diseases.
5. *Root-knot* — See under Peach, and (37) Root-knot under General Diseases.
6. *Thread Blight* — Southeastern states. Plants may be defoliated early. See under Walnut. *Control:* Spray as for Leaf Spots (above).

PLANETREE (*Platanus*) — See Sycamore

PLANTAINLILY — See Hosta

PLATYCODON — See Bellflower

PLUM — See Peach

PLUMARIS — See Carnation

PLUMED THISTLE — See Chrysanthemum

PLUME HYACINTH — See Tulip

PLUMERIA — See Oleander

PLUM - YEW — See Japanese Plum-yew

PODOCARPUS — See Yew

PODOPHYLLUM — See Mayapple

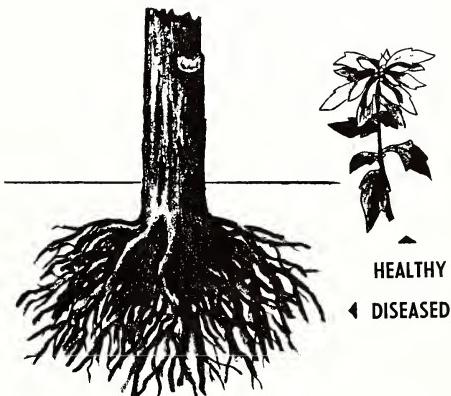
PODRANAEA — See Catalpa

POINCIANA — See Honeylocust

POINSETTIA, SPURGE [CYPRESS, FLOWERING, PAINTED or MEXICAN FIRE - PLANT], SNOW - ON - THE - MOUNTAIN, CROWN-OF-THORNS (*Euphorbia*)

1. *Stem Rots, Foot Rots, Root Rots, Wilt* — Serious indoor problem. Plants stunted, frequently decline and die. Cuttings (or stems) are rotted near the soil line. Cuttings may fail to root. Stems, branches, and roots darken, eventually die. Leaves gradually wither, turn yellow, and drop off. This symptom is first noticeable at the base, from there it gradually covers the whole plant. Flowers are stunted, may

Fig. 155. Poinsettia root rot (*Thielaviopsis*).



be one-sided. See Figure 155. *Control:* Avoid overwatering, overcrowding, and splashing water on the foliage when sprinkling. Take tip cuttings from vigorous, disease-free plants. Dip in ferbam and root in light, well-drained, sterilized soil which is acid (pH 4.5 to 4.9). Practice strict sanitation (e.g., use new pots or disinfect old pots). Indoors, maintain the recommended temperature at night and regulation of day length. If misting, reduce the mist period to 30 seconds and increase the no-mist period to 1½ to 2 minutes. Check with your local florist or extension horticulturist. Florists drench the cutting bed after cuttings are "stuck," using thiram, Semesan, or Pano-drench. Drench the soil monthly (1 quart per square foot) for three applications using a mixture of Terraclor plus ferbam, captan, thiram, or phaltan. Destroy severely infected plants.

2. *Gray-mold Blight, Botrytis Tip Blight, Stem Canker* — Flower clusters, especially on double varieties, and colored bracts are blasted and turn brown. Brown cankers form on the stem. A grayish mold grows over infected areas in cool, damp weather. *Control:* Indoors, space the plants, increase air circulation, and raise the temperature. Otherwise the same as for Stem Rots (above). Maneb, zineb, or fixed copper sprays will often be beneficial. Carefully pick off and burn affected parts.
3. *Bacterial Canker and Leaf Spot, Bacterial Blight* (poinsettia) — Long, narrow, dark, water-soaked streaks on the green stems and petioles. Stems may crack open and ooze. The growing point curves down and in. Light spots or blotches occur on the leaves which later turn brown. Infected leaves may drop early. Several branches may be completely blighted or the entire plant may die. Plants may show no symptoms for several months after becoming infected. *Control:* Same as for Stem Rots (above). Avoid overfertilizing plants. Streptomycin sprays are beneficial.
4. *Crown Gall* — Irregular galls at the base of plants. *Control:* Destroy infected plants. Root cuttings in sterilized soil (pages 437-44). Avoid wounding plants.
5. *Chlorosis* — Plants a sickly yellow. Lack vigor. *Control:* Plant in acid soil. Apply a complete fertilizer based on a soil test.
6. *Leaf and Stem Spots, Scab or Spot Anthracnose* — Small spots on the leaves; sometimes on the stems. Young stems may die back. Leaves may drop prematurely. *Control:* Same as for Gray-mold Blight (above).
7. *Rusts* — See under Chrysanthemum.
8. *Root-knot* — See (37) Root-knot under General Diseases. Plant growth is reduced.
9. *Powdery Mildew* (snow-on-the-mountain, spurge) — See (7) Powdery Mildew under General Diseases.
10. *Stem Smut* — (painted spurge) — Louisiana. See (11) Smut under General Diseases.

POKERPLANT — See **Redhot - pokerplant**

POLEMONIUM, POLYGALA — See **Phlox**

POLIANTHES — See **Daffodil**

POLYANTHUS — See **Primrose**

POLYGONUM — See **Silver Lacevine**

POLYPODIUM, POLYSTICHUM — See **Ferns**

POMEGRANATE (*Punica*)

1. *Fruit Spots and Rots* — Cosmopolitan. Rot spots develop in the fruit. Affected areas may be covered with a gray, blue, or black mold growth. See under Apple.
2. *Anthracnose, Spot Anthracnose, Leaf Blotch* — See under Maple.
3. *Root-knot* — See (37) Root-knot under General Diseases.
4. *Root Rot* — See under Apple, and (34) Root Rot under General Diseases.
5. *Thread Blight* — Southeastern states. See under Walnut.

PONCIRUS — See **Citrus**

PONDLILY — See **Waterlily**

POND - SPICE — See **Avocado**

POPCORN — See **Corn**

POORMANS - ORCHID — See **Tomato**

POPLAR [BALM - OF - GILEAD, BALSAM, BERLIN, BLACK, BOLLEANA or TURKESTAN, CAROLINA, CHINESE, COARSE - TOOTHED, GRAY, JAPANESE, KOREAN, LOMBARDY, MONGOLIAN, NORWAY, RIO GRANDE, SIMON, SILVER, WHITE], ASPEN [CHINESE, GOLDEN, JAPANESE, LARGE - TOOTHED, QUAKing or QUIVERLEAF], COTTONWOOD [BLACK or WESTERN BALSAM POPLAR, COMMON or NORTHERN, COTTONLESS, EASTERN, GREAT PLAINS, SOUTHERN, SWAMP] (*Populus*)

1. *Twig, Branch, and Trunk Cankers, Dieback* — General and serious. Rough, discolored, cracked, often sunken cankers on the twigs, branches, and trunk. Girdled parts cause the foliage beyond to die. Cankers may cause swellings on the trunk and formation of suckers on the trunk which become infected and die. The sapwood under the cankers is discolored. Twigs and small branches die back first. Trees often die from the top down. *Control:* Use poplars best adapted to your area. Check with your extension horticulturist or nurseryman. Avoid wounding trees. Paint over wounds promptly with tree wound dressing. If practical, prune out all cankers on small branches. Disinfect cut surfaces with a 1:1,000 solution of mercury bichloride followed by tree paint. Lombardy, Bolleana, and Simon poplars are very susceptible to one or more cankers. Poplars and cottonwoods vary greatly in resistance. Certain cankers are so contagious that infected trees should be removed and burned. Water during droughts. Fertilize to maintain vigor. Sprays of fixed copper, zineb, or captan when applied at 2-week intervals, to nursery-size trees has proved beneficial. For additional information check with your extension horticulturist or plant pathologist.
2. *Leaf Spots, Leaf Blotch, Ink Spot* — Common but not serious. Small to large, round to irregular leaf spots of various colors, often with dark margins. Spots often later enlarge. Leaves wither and fall early. Twigs may be killed back. *Control:* Collect and burn fallen leaves. If serious enough, apply two or three sprays, 10 days apart, starting when the buds break open, using phenyl mercury, zineb, fixed copper, or bordeaux (4-4-50).
3. *Powdery Mildews* — Widespread. White, powdery mold patches on the leaves. *Control:* If serious enough, spray several times, 10 days apart, using sulfur, Actidione, or Karathane.
4. *Leaf Rusts* — General. Bright, yellowish-orange, dusty pustules, usually on the underleaf surface. Pustules may later turn reddish-brown to black. Leaves may fall early. Seldom causes serious damage. *Control:* Where practical, avoid planting near the alternate hosts: garlic, Douglas-fir, hemlock, bigcone spruce, and larch. If practical, apply zineb, maneb, dichlone, Actidione, ferbam, or sulfur two or three times, 10 days apart, starting a week before rust normally appears.
5. *Spring Leaf Fall, Scab, Shoot Blight* — In late spring the tips of young leaves turn black. Affected areas enlarge, causing the leaves to blacken, wrinkle, wither, and drop by late spring. Shoots may be blighted causing loss of tree vigor. *Control:* Spray as for Leaf Spots (above). Prune out and burn blighted shoots. Fertilize and water to maintain tree vigor.
6. *Wood Rots, Butt Rot* — Cosmopolitan. See under Birch, and (23) Wood Rot under General Diseases.
7. *Yellow Leaf Blisters, Catkin Deformity* — Widespread. Irregular, small to large, bright yellow to brown blisters on the leaves following cold, wet spring weather. Underleaf surface may show a bright golden "bloom." Catkins are deformed. *Control:* If practical, apply fixed copper or ferbam before buds swell in early spring.
8. *Wetwood, Slime Flux* — See under Elm.

9. *Branch Gall* — Small, rounded galls up to $1\frac{1}{2}$ inches in diameter, develop at the base of the twigs. Some twigs and small branches may die back. *Control:* Prune infected branches and dead twigs back several inches into healthy wood. Burn the prunings.
10. *Crown Gall* — Also called Bacterial Limb Gall. Rough, irregular, swollen galls usually found at the base of the trunk or on the roots. Trees lack vigor. Make poor growth. *Control:* See under Apple, and (30) Crown Gall under General Diseases.
11. *Root Rots* — Trees gradually decline in vigor. Foliage becomes thin and sickly. Leaves may turn yellow and drop early. May be associated with nematodes (e.g., ring, sheath). See under Apple, and (34) Root Rot under General Diseases.
12. *Verticillium Wilt* — See under Maple, and (15B) Verticillium Wilt under General Diseases.
13. *Seed Rot, Damping-off* — See under Pine.
14. *Mistletoe* — See (39) Mistletoe under General Diseases.
15. *Chlorosis, Iron Deficiency* — See under Maple.
16. *Sooty Mold* — See (12) Sooty Mold under General Diseases.

**POPPY [ALPINE, CORN, ICELAND, ORIENTAL] (*Papaver*);
 PRICKLY - POPPY [CRESTED, MEXICAN] (*Argemone*); CELANDINE
 (*Chelidonium*); CALIFORNIA - POPPY (*Eschscholtzia*); TREEPOPPIY
 or BUSHPOPPY (*Dendromecon*); MECONOPSIS, WELSH POPPY
 (*Meconopsis*); BLOODROOT (*Sanguinaria*)**

1. *Bacterial Blight* (poppy, California-poppy) — Small, water-soaked spots or blotches on the leaves, stems, flowers, seedpods, and roots. Spots soon turn black with a slimy exudate. Leaves may wither and drop early. Stems may be girdled, causing plants to die. *Control:* Cut off and burn severely infected parts. Pick off and burn spotted leaves on mildly infected plants. Plant seed from disease-free plants in clean or sterilized soil (pages 437-44). Spray with a copper fungicide during wet weather. Streptomycin may also work.
2. *Stem and Root Rots, Damping-off* — Seedlings sickly, wilt, and collapse. Older plants turn pale, wilt, and wither from a rot or canker of the lower stem or roots. *Control:* Plant disease-free plants or seed in clean or sterilized soil which is light and well-drained. Avoid overwatering, excessive use of fertilizers high in nitrogen, and wounding plants. Drench crown with a mixture of Terraclor plus captan or ferbam if suspicious (page 92). Rotate. Spray as for Downy Mildew (below). Treat seed of California-poppy by soaking in hot water (125° F.) for 30 minutes.
3. *Leaf and Seedpod Spots* — Spots of various sizes, shapes, and colors on the leaves and seedpods. Leaves may die around blossom time. *Control:* Plant seed from disease-free plants. Spray as for Downy Mildew (below). Treat seed of California-poppy as for Stem and Root Rots (above).
4. *Downy Mildew* (poppy, prickly-poppy, meconopsis) — Seedlings blighted. May collapse and die. Yellowish or light brown spots and blotches develop on the upper leaf surface of older plants. The blotches later enlarge and become very dark. Spots on the underleaf surface are covered with white, grayish, or purplish mold in damp weather. Leaves may turn yellow, wither, and be deformed. Stems are distorted. Buds, flower parts, seeds, and capsules may also be infected. Plants may fail to bloom. *Control:* Destroy the first infected plants. Pick off and burn infected plant parts when they appear. Burn tops in the fall. Plant seed from disease-free plants in well-drained soil. Apply zineb, maneb, or copper several times, 7 to 10 days apart, in cool, rainy weather.
5. *Verticillium Wilt* — Plants turn yellow, wilt, and die. Often fail to bloom. Stems may turn brown. *Control:* See (15B) Verticillium Wilt under General Diseases.

6. *Curly-top, Aster Yellows* — Plants severely stunted, bunched, and yellowed. *Control:* Destroy infected plants when first found. Keep down weeds. Spray at least weekly with DDT and malathion to control leafhoppers which transmit the viruses.
7. *Spotted Wilt* — Leaves stunted, twisted, and gradually turn yellow. Plants are stunted, pale, and bunched. May die suddenly. Flower stems are stunted. Often twisted and bent over. *Control:* Same as for Curly-top and Aster Yellows (above). The virus is transmitted by thrips.
8. *Black Ringspot* — See under Cabbage.
9. *Leaf Smut* — Pale leaf spots which turn dark brown or black, with a reddish border. *Control:* Same as for Bacterial Blight (above). Spray or dust as for Downy Mildew (above).
10. *Gray-mold Blight* — See (5) Botrytis Blight under General Diseases.
11. *Leaf Nematode* (poppy) — See (20) Leaf Nematode under General Diseases.
12. *Root-knot and other Nematodes* (e.g., root-lesion) — See (37) Root-knot under General Diseases.
13. *Powdery Mildew* — Pacific coast. Grayish-white, powdery mold patches on the leaves. *Control:* If serious enough, apply Karathane or sulfur several times, at 10-day intervals.
14. *Black Mold* — Sootlike mold patches on the foliage following attacks by insects. *Control:* Apply malathion as needed to keep insects in check.
15. *Rust* (prickly-poppy) — See (8) Rust under General Diseases. Spray as for Downy Mildew (above).

POPPY - MALLOW — See Hollyhock

POPULUS — See Poplar

PORCELAIN BERRY — See Grape

PORT ORFORD CEDAR — See Juniper

PORTULACA — See Rose - moss

POSSUMHAW — See Holly and Viburnum

POTATO (*Solanum*)

1. *Common Scab* — General. Shallow, rough, russeted, raised or pitted, corky areas on the tuber surface. Tubers often do not keep well in storage. See Figure 28A under General Diseases. *Control:* Plant scab-free tubers in scab-free soil. Treat seed-pieces as for Seed-piece Decay (below). Three- or 4-year rotation. Include green manure crops (page 16). Somewhat resistant varieties: Antigo, Avon, Blanca, Catoosa, Cayuga, Cherokee, Early Gem, Haig, Huron, Knik, Menominee, Navajo, Norland, Onaway, Ontario, Osage, Plymouth, Redkote, Redskin, Russet Burbank, Russet Rural, Russet Sebago, Sebago, Seneca, Tawa, and Yampa. Check to see if these varieties are adapted to your area by contacting a local grower, your extension horticulturist, or potato specialist. If practical, mixing sulfur, urea-formaldehyde (UF-85, Uracide, N-Dure), or Terraclor into the top 6 inches of soil in the row may help. Check with the authorities mentioned above or your extension plant pathologist. Avoid application of alkaline materials, e.g., lime, wood ashes, and manure to potato soil.
2. *Early Blight, Target Spot* — General. Small, dark brown, often zoned spots on the leaves. Spots may run together to kill a portion of the leaf. See Figure 156. Dark, slightly sunken spots develop on the stems and tubers in storage. *Control:* Apply maneb, zineb, or fixed copper at 7- to 10-day intervals, or just before rainy periods.

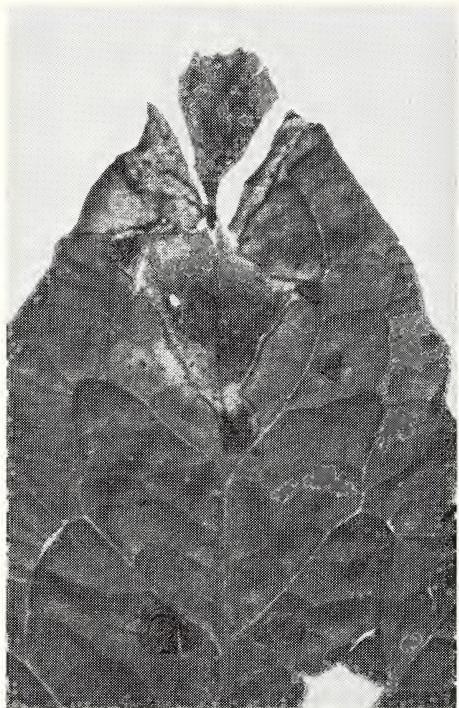


Fig. 156. Early blight of potato (extreme closeup). (Courtesy Illinois Agricultural Experiment Station)

Destroy (burn or dig under) volunteer potatoes and plant debris after harvest. Store tubers in a dry, well-ventilated location just above freezing. Keep down weeds. Dig tubers 2 to 3 weeks after the vines die. Plant disease-free, certified seed potatoes. Bordeaux mixture (6-3-50) is often suggested for the last 1 to 3 sprays when late blight threatens. Potato varieties differ in resistance. Three-year rotation with crops outside the potato-tomato family.

3. *Late Blight* — General and serious in cool, damp weather. Large, irregular, dark green to grayish-purple, water-soaked areas on the leaves, petioles, and stems. In damp weather, a whitish mold growth appears — mostly on the underleaf surface. Infected areas later turn dark brown or blacken, dry out, and die. May resemble frost damage. Entire tops may die within a few days in cool, wet weather. Slightly sunken, dark brown to purple blotches form on the tubers. Tubers decay in storage. *Control:* Same as for Early Blight (above). Maintain high, balanced fertility especially of phosphorus and potassium. Varieties resistant to one or more races of late blight: Ashworth, Avon, Boone, Catoosa, Cayuga, Cherokee, Delus, Empire, Fundy, Kennebec, Menominee, Merrimack, Ontario, Plymouth, Pungo, Russet Sebago, Saco, Saranac, Sebago, and Tawa. More highly resistant varieties will be available in the future. Check with your county agent, extension horticulturist, potato specialist, or plant pathologist.
4. *Tuber Rots* — Cosmopolitan. Tubers rot slowly or rapidly in field or storage. Rot may be firm, watery, or slimy and foul-smelling (Bacterial Soft Rot). Rots develop rapidly under warm, moist conditions. Mold may grow on affected areas. See Figure 43A under General Diseases. *Control:* Store only sound, dry, blemish-free tubers

in clean, well-ventilated storage at 40° F. First store tubers at 50° to 60° F. for 2 to 3 weeks (or 60° to 85° F. for 1 week) to heal cuts and bruises. Check with your potato specialist or extension horticulturist. Also control measures as for Seed-piece Decays (below).

5. *Seed-piece Decays* — General. Seed-pieces rot in the soil. Poor stand. Emerging plants may be stunted and sickly with rolled yellowish leaves. *Control:* Plant certified, disease-free tubers, well corked over, and treated with dichlone, chloranil, captan, maneb, zineb, thiram, or Semesan Bel. Follow the manufacturer's directions. The addition of streptomycin (200 parts per million) will often help control Blackleg. Avoid heavy, poorly drained soils. Four- to 6-year rotation. Before planting, apply chlordane, aldrin, or dieldrin to the soil surface and then work it into the top 6 inches of soil. Follow the manufacturer's directions. This treatment controls wireworms and other insects which attack the seed-piece, roots, and tubers.
 6. *Blackleg* — General in wet seasons or in poorly drained soils. Yellowish, stunted, wilting plants. Stem base is slimy, black, and rotted. Infected plants are easily pulled up. Tubers show slimy, black, stem-end rot. Tuber rot develops rapidly in warm, moist storage. Often follows borers or other injuries. See Figure 43A under General Diseases. *Control:* Same as for Seed-piece Decays (above). Control insects. See under Virus Complex (below) and Seed-piece Decays (above).
 7. *Virus Complex* (mosaics, crinkle, calico, corky ringspot, leafrolls, mottle, streak, curly-top or green dwarf, aster yellows or purple-top, witches'-broom, vein-banding, ringspot, yellow spot, yellow dwarf) — General. May be serious. Symptoms variable depending on the viruses and strains involved, variety, age, weather conditions, and other factors. Leaves may show light green or yellow and dark green mottling, streaking, crinkling, or rolling of the leaves. Leaves may be stunted, stiff, leathery, and puckered. Plants often dwarfed and bushy. Aerial tubers often form along the stem. Corky areas may form in the tubers (Corky Ringspot). Shoot tips may be purplish (Purple-top). Yield is reduced. *Control:* Apply sprays at 7- to 10-day intervals to control insects, especially aphids and leafhoppers, which transmit the viruses. Use DDT and malathion. Alternate these materials with dieldrin. Keep down weeds. Plant only certified, virus-free seed tubers. Destroy the first infected plants when found. Varieties resistant to one or more viruses: Cherokee, Chippewa, Houma, Katahdin, Kennebec, Menominee, Merrimack, Mohawk, Ontario, Plymouth, Pungo, Redskin, Red Warba, Russet Sebago, Saco, Sebago, Tawa, and Warba. Check with your potato specialist or extension plant pathologist regarding the potato viruses prevalent in your area.
 8. *Wilts* — Potatoes are infected by all three common wilts: Fusarium, Verticillium, and Bacterial. See (15) Wilts under General Diseases.
 - A. *Fusarium Wilt, Dry Rot, Rusty Dieback* — Most serious in hot, dry weather. Yellowish or bronzed leaves. Plants stunted, gradually or suddenly wilt and die. Brown streaks inside stems and tubers. Firm, leathery, cheesy, dry rot of tubers.
 - B. *Verticillium Wilt, "Pink Eye"* — A cool season disease. Plants wilt gradually or suddenly around flowering time. Lower leaves become a mottled yellow and droop first. Leaflets may roll. Tips are yellowed. Stem-end of tuber is discolored around the eyes. Brown streaks occur inside the stems. Roots are decayed.
 - C. *Bacterial Wilt, Brown Rot* — Mostly in southeastern states. See under Tomato. Plants gradually wilt and die. Stems turn brown, at first only on the inside. Brown rot of tubers with ooze sticking to the surface.
- Control for Wilts:* Plant certified, disease-free seed grown in northern states. Treat seed as for Seed-piece Decays (above). Four- to 6-year rotation excluding crops in the potato family. Avoid injuring tubers. Disinfect storage locations. See

under Bacterial Ring Rot (below). Increase ventilation in storage. Discard tubers with rot, discolored "eyes," or a sticky ooze on the surface. Varieties reported as having some resistance to *Verticillium Wilt*: Chippewa, Green Mountain, Houma, Katahdin, Menominee, Ontario, Pontiac, Red Beauty, Russet Burbank, Saranac, Sequoia, and Tawa. Sebago and Katahdin have weak resistance to Bacterial Wilt. Check with your extension horticulturist, potato specialist, or county agent regarding the adaptability of these varieties to your area.

9. *Rhizoctonia or Black Scurf, Stem Rot and Canker* — General. Serious in cold, wet springs. Dark brown or black hard bodies (sclerotia) on the tuber surface which do not rub off. Dark brown, sunken cankers form at the base of the stem and on the stolons. Plants may be stunted with leaves rolled and a sickly yellow color. Green or reddish aerial tubers may form in the leaf axils near the stem base. Roots may be killed back. Stand and yield is often reduced. A light, grayish-brown powdery mold grows on the lower stem during damp summer weather. *Control*: Plant certified, disease-free seed in warm, well-drained, fertile soil. Treat seed as for Seed-piece Decays (above). Terraclor worked into the top 4 to 6 inches of soil before planting may help on mineral soils. Follow the manufacturer's directions. Four- to 6-year rotation. Harvest early. Potato varieties show differences in susceptibility.
10. *Hollow Heart* — Large tubers develop irregular, hollow, center heart or cavity with a dark corky border. Common in seasons favorable for late, rapid growth (excessive soil moisture and fertility). *Control*: Space plants closer together in the row. Plant varieties with a high dry-matter content. Check with your county agent, extension horticulturist, or potato specialist.
11. *Blackheart* — Internal, dark gray to coal-black rot of tubers. Rotted tissue is firm. *Control*: Same as for Tuber Rots (above). Do not store in large, solid piles. Dig promptly when the soil temperature is warm.
12. *Bacterial Ring Rot* — General. Foliage symptoms are variable. Mottled rolled leaves on erect stems. Plants may wilt during the day and recover at night. Tubers often have yellowish pockets or a "cheesy" ring, about $\frac{1}{4}$ inch deep under the skin, especially after a storage period. Rot develops rapidly in storage. *Control*: Plant certified, disease-free tubers. Disinfect cutting knives with mercuric chloride (1:500 solution) or Semesan Bel (4 ounces per gallon). Or plant small, uncut tubers. Stringent sanitation of all equipment, tools, and storage areas using formaldehyde (1 pint in 15 gallons of water) or copper sulfate (1 pound to 5 gallons). Use new or clean sacks for seed tubers or dip in formaldehyde solution. Teton, Merrimack, and Saranac are resistant varieties. Control insects, especially Colorado potato beetles, plant bugs, aphids, and leafhoppers, which may transmit the causal bacteria. See under Virus Complex (above).
13. *Spindle Tuber* — General. Symptoms differ greatly with the variety. Plants are often dwarfed, spindly, and more erect than normal with dwarfed, dark green leaves. Tubers usually elongated. Often pointed at the stem end and with shallow eyes. *Control*: Same as for Virus Complex (above).
14. *Nematode Diseases* — (1) Diseased plants may have small, round to irregular, knotty galls on the roots and tubers (Root-knot and Golden Nematode). (2) Tuber may be spotted with small, raised pustules which tend to run together (Potato Rot and Stem Nematodes). Infected areas later turn gray to brown, shrink, and become sunken. (3) Plants may be stunted and sickly with discolored, stubby or "bushy" roots (dagger, lance, reniform, ring, root-lesion, spiral, sting, stubby-root, and stunt or stylet nematodes). Plants may become stunted and sickly. Often wilt during midday. Yield is often reduced. *Control*: Prevent contamination of clean soil. Plant certified, disease-free seed. Three- to 6-year rotation. Keep down weeds.

- Fumigate the soil if practical (pages 440-44). Check with your extension plant pathologist or potato specialist.
15. *Tipburn, Hopperburn* — General. Tips and outer margins of leaves turn brown and curl in hot, dry weather. Plants turn pale green or yellow. Ripen prematurely. Yield is often reduced. Commonly confused with blights. *Control:* Control leaf-hoppers. See under Virus Complex (above). Follow the best cultural practices. Check with your county agent, extension entomologist, or potato specialist. Potato varieties differ in resistance.
 16. *Psyllid Yellows* — Western half of the United States. Leaves turn yellow to purplish at the margins and roll upwards. Brown dead areas later develop in the leaves which wither and die prematurely. Plants are stunted and bushy. Aerial tubers sometimes form along the entire stem. Yield may be greatly reduced. *Control:* Spray with DDT to control psyllid insects.
 17. *Black Dot Disease, Anthracnoses* — General but a minor problem. Stems cankered and girdled just below the soil line by dark brown and dead areas with black dots. Foliage is yellowed with rolled leaves. Tops may die early. Tubers show silvery-gray patches, covered with black dots. *Control:* Plant certified, disease-free seed in well-drained soil. Four- to 6-year rotation. Burn or compost plant debris after harvest.
 18. *Powdery Scab, Canker* — Occasional in northern states. Small, dark, slightly raised pustules on the tubers which later break open and release powdery masses. Large, sunken cankers may form. *Control:* Same as for Black Dot Disease (above).
 19. *Knobbiness, "Second Growth," Malformed Tubers* — Tubers branch and grow indeterminately. May develop cracks and cavities or the skin may be corky. *Control:* Plant certified, disease-free seed of good size (1½ to 2 ounce seed-piece). Maintain as uniform a soil moisture supply as possible. Control diseases and insects. Spray regularly with a multipurpose mixture containing zineb or maneb plus either DDT or methoxychlor and malathion.
 20. *Stem Rots, Stalk Disease, Southern Blight, Tuber Rots* — See Bean White Mold.
 21. *Minor Leaf Spots and Blotches* — Spots of various colors and shapes on the leaves. *Control:* Same as for Early Blight (above).
 22. *Powdery Mildews* — Usually minor. See (7) Powdery Mildew under General Diseases. Powdery white mold on both leaf surfaces. Leaves later turn yellow, wither, and die. Vines die back and later collapse.
 23. *Leaf Scorch* — Plants often stunted or dwarfed with tips and margins of the leaves scorched. May be curled. *Control:* Have the soil tested. Apply fertilizer as recommended. May be due to a deficiency of magnesium, potassium, or calcium.
 24. *Web Blight* — Southeastern states. See under Bean.
 25. *Crown Gall* — See (30) Crown Gall under General Diseases.
 26. *Root Rots* — See (34) Root Rot under General Diseases.
 27. *Black Walnut Injury* — Plants growing under black walnut trees wilt and die. Roots are decayed. *Control:* Avoid growing within 50 feet or more of these nut trees.

POTENTILLA — See Rose**POTHOS — See Calla****POT MARIGOLD, PRAIRIE - CONEFLOWER — See Chrysanthemum****POWDER - PUFF TREE — See Calliandra**

PRAIRIEGENTIAN — See **Gentian**

PRAIRIE LILY — See **Mentzelia**

PRAIRIE ROCKET — See **Cabbage**

PRAAYER PLANT — See **Rabbit Tracks**

PRETTY - FACE — See **Brodiaea**

PRICKLY - ASH — See **Hoptree**

PRICKLY - POPPY — See **Poppy**

PRIMROSE — See **Evening - primrose and below**

PRIMROSE [**CHINESE, ENGLISH, FAIRY**], **COWSLIP, OXLIP, POLYANTHUS** (*Primula*); **PIMPERNEL, SCARLET PIMPERNEL, ANAGALLIS** (*Anagallis*); **ROCKJASMINE** (*Androsace*); **SHOOTINGSTAR or AMERICAN COWSLIP, SIERRA SHOOTINGSTAR, MOSQUITO BILLS** (*Dodecatheon*); **LOOSESTRIFE** [**GARDEN, SWAMP-, WATER or TUFTED**], **MONEYWORT or CREEPING CHARLIE** (*Lysimachia*)

1. *Gray-mold Blight, Botrytis Blight, Flower Blight* — Common indoors, occasional outdoors. Crowns and roots rot. Large rotted spots on the flower heads and leaves. Affected plant parts are covered with a dense gray mold in damp weather. *Control:* Avoid overwatering and overcrowding plants. Remove fading flowers. Indoors, keep water off the foliage and increase the air circulation. Plant in well-drained soil, sterilized if possible (pages 437-44). Apply zineb or captan sprays before rainy periods.
2. *Fungus Leaf Spots or Blight, Anthracnose, Black Spot, Downy Mildew* — Spots or blotches on the leaves. Of various colors, shapes, and sizes. *Control:* Same as for Gray-mold Blight (above). In addition, apply zineb or fixed copper at 10-day intervals. Start when disease is first noticed.
3. *Bacterial Leaf Spot* — Small, water-soaked spots with yellowish centers on the older leaves. Later the spots turn brown and develop pale yellowish halos. Spots may run together forming large, irregular, dead blotches. *Control:* Same as for Gray-mold Blight (above). Plant resistant varieties. Spraying with fixed copper or streptomycin should be beneficial.
4. *Stem Rots, Root Rots* — Leaves mottled and sickly. Later turn yellow and wither. Plants may wilt and collapse due to a brown or black rotting of the stem or roots. *Control:* Avoid overwatering. Where possible plant in clean or sterilized soil. See pages 437-44 in the Appendix. A soil drench of Terraclor (PCNB) applied when disease is first evident may be beneficial.
5. *Damping-off* — Seedlings wilt, collapse, and die. *Control:* Same as for Gray-mold Blight (above).
6. *Mosaics* — Leaves mottled yellow and dark green, often cupped. Young leaves and plants are stunted. Flowers are flecked and streaked. *Control:* Destroy infected plants. Control insects, especially aphids, which transmit at least one virus. Use malathion or lindane.
7. *Spotted Wilt* — Leaves and plants are stunted and yellowish. Few flowers are produced. Irregular dead spots or blotches may develop in the leaves. Entire leaf may die. *Control:* Same as for Mosaics. Virus is spread by thrips.
8. *Aster Yellows* — See (18) *Aster Yellows* under General Diseases.

9. *Chlorosis* — Primarily an indoor problem. Leaves develop a yellowish or whitish mottling. Varieties differ in susceptibility. *Control*: Avoid overwatering, overfertilizing, and too acid or alkaline a soil. Follow the best cultural practices. Adding some iron sulfate to the soil or applying as a spray is often beneficial.
10. *Rusts* — See (8) Rust under General Diseases.
11. *Powdery Mildew* — See under Chrysanthemum. Foliage may wither and dry up.
12. *Root-knot* — See (37) Root-knot under General Diseases.
13. *Leaf and Stem Nematode* — See (20) Leaf Nematode under General Diseases.

PRINCESFEATHER — See Cockscomb

PRINCESSTREE — See Paulownia

PRIVET [AMUR, BIGBERRY, CALIFORNIA, CHINESE, COMMON or EUROPEAN (many horticultural forms), GLOSSY or WAXLEAF, IBOILIUM, IBOTA, INDIAN, JAPANESE, LODENSE, QUIHOU, REGEL] (Ligustrum)

1. *Anthracnose, Canker, Twig Blight, Dieback* — General and serious. Leaves wilt, turn brown, shrivel, and cling to the stem. Twigs blighted and killed by girdling brown cankers at the base of the main stem. Common and Lodense privets are very susceptible. *Control*: Cut out and burn infected parts. Apply zineb or ferbam at weekly intervals during wet weather. Resistant varieties: Amur, California, Ibota, and Regel.
2. *Wood Rots, Collar Rot* — Cosmopolitan. See under Birch, and (23) Wood Rot under General Diseases.
3. *Root Rots* — Plants in hedge gradually die in one or several places. Areas tend to increase in size each year. Plants sickly and make poor growth. Foliage is thin and yellowish or brown. Roots are rotted. May be associated with root-feeding nematodes (e.g., lance, needle, pin, ring, root-knot, root-lesion, spiral, stem, stubby-root, stylet or stunt). *Control*: Dig up and destroy all of affected plants and 2 apparently healthy ones on each side. Include all the roots. Drench soil where these plants were growing using Vapam or V.P.M. Soil Fumigant, or replace with new soil.
4. *Crown Gall* — Occasional. See under Apple, and (30) Crown Gall under General Diseases.
5. *Powdery Mildew* — Powdery, whitish patches or blotches on the upper leaf surface. *Control*: If serious, dust or spray with sulfur or Karathane.
6. *Minor Leaf Spots, Leaf Blights* — Prevalent during rainy seasons on overcrowded plants. Spots of various colors, sizes, and shapes on the leaves. *Control*: If serious enough, apply zineb, maneb, or fixed copper before rainy periods. Prune to thin out overcrowded plants.
7. *Sooty Mold* — Blackish growth on leaves following insect attacks. *Control*: Apply malathion sprays to control insects.
8. *Root-knot* — See under Peach, and (37) Root-knot under General Diseases.
9. *Stem Gall* — More or less circular galls up to 2 inches in diameter at the crown or base of stem. Plants may die. *Control*: Cut out and burn stems infected with gall. Do not replant in the same area without first sterilizing the soil (pages 437-44). See under Root Rots (above). Avoid wounding stem bases.
10. *Chlorosis* — Mineral deficiency in alkaline soils. See under Maple. *Control*: Have the soil tested. Treat as recommended.

11. *Mosaic, Variegation, Chlorotic Spot, Ringspot* — Leaves mildly mottled, puckered, and distorted. May be stunted, spotted, or ringed with yellow. *Control:* Dig up and burn infected plants. Set out virus-free plants from a reputable nursery.
12. *Witches'-broom* — See under Lilac.
13. *Leaf Nematode* — See (20) Leaf Nematode under General Diseases.
14. *Thread Blight* — See under Walnut.

PROBOSCISFLOWER, DEVILSCLAW, UNICORNPLANT (*Proboscidea*)

1. *Fungus Leaf Spots* — Brown to gray spots with reddish or purple margins. *Control:* Pick off and burn spotted leaves. If serious, spray several times during rainy weather, 10 days apart, using zineb, maneb, or fixed copper.
2. *Bacterial Leaf Spot* — Minute, angular, sunken, water-soaked spots on the leaves, petioles, and stems. Spots may run together forming irregular, light brown patches. Plants may die. Fruit may become brown and shriveled. *Control:* Plant disease-free seed from healthy pods. Destroy infected plant parts and severely infected plants.
3. *Stem or Crown Rot* — Stem rots at the soil line. Plants may wilt and collapse. Rotted area may be covered with a cottony mold. *Control:* See under Delphinium.
4. *Mosaics* — See (16) Mosaic under General Diseases.
5. *Root Rot* — See (34) Root Rot under General Diseases.

PRUNE, PRUNUS — See Peach

PRUNELLA — See Salvia

PSEUDOLARIX — See Larch

PSEUDOTSUGA — See Pine

PSIDIUM — See Myrtle

PTELEA — See Hoptree

PTERIDIUM, PTERETIS, PTERIS — See Ferns

PUCCOON — See Mertensia

PUMPKIN — See Cucumber

PUNICA — See Pomegranate

PURPLE - CONEFLower — See Chrysanthemum

PURPLE - FLOWERED GROUNDCHERRY — See Tomato

PURPLELEAF BUSH, PURPLELEAF PLUM — See Peach

PURPLELEAF SPIDERWORT — See Rhoea

PURPLE RAGWORT — See Chrysanthemum

PURPLE ROCKCRESS — See Cabbage

PURPLE SMOKEBUSH — See Sumac

PUSCHKINIA — See Tulip

PUSSYTOES — See Chrysanthemum

PYCNANTHEMUM — See Salvia

PYRACANTHA — See **Apple**

PYRETHRUM — See **Chrysanthemum**

PYRUS — See **Apple**

QUAKER BONNETS — See **Pea**

QUAMOCЛИT — See **Morning - glory**

QUEEN - OF - THE - MEADOW, QUEEN - OF - THE - PRAIRIE — See **Rose**

QUEENS - DELIGHT — See **Castorbean**

QUERCUS — See **Oak**

QUINCE — See **Apple**

QUINCOLA — See **Tomato**

QUIVERLEAF — See **Poplar**

RABBIT TRACKS, PRAYER PLANT, ARROWROOT (*Maranta*); CALATHEA

1. *Leaf Spots* — See (1) *Fungus Leaf Spot* under General Diseases.

2. *Rust* — See (8) *Rust* under General Diseases.

3. *Root-knot* — See (37) *Root-knot* under General Diseases.

4. *Other Root Nematodes* (burrowing, spiral) — Often associated with sickly plants.

Control: Same as for Root-knot. Plant in sterilized soil.

RADISH — See **Cabbage**

RAINLILY — See **Daffodil**

RANUNCULUS — See **Delphinium**

RAPE — See **Cabbage**

RASPBERRY [AMERICAN RED or COMMON RED, BLACK or BLACKCAP, GOLDEN EVERGREEN, PURPLE FLOWERING, PURPLECANE, RED, ROSELEAF, WESTERN RED, WHITE BARK, WHITE FLOWERING], BLACKBERRY [ALLEGHANY or AMERICAN, CUT - LEAVED, EUROPEAN, EVERGREEN, Highbush, HIMALAYA, TRAILING, THORNLESS, YANKEE], BOYSENBERRY, DEWBERRY [CALIFORNIA, CULTIVATED AMERICAN, GRAPPELEAF, NORTHERN, SOUTHERN], CLOUDBERRY, LOGANBERRY, MAMMOTH BLACKBERRY, SALMONBERRY, THIMBLEBERRY (*Rubus*)

1. *Anthracnose, Spot Anthracnose, Gray Bark* — General and serious. Small, reddish-brown to purple spots on young shoots and fruit spurs which enlarge, become more or less circular with sunken, light gray centers and purple borders. Fruits are often small, dry, and seedy. Small yellowish spots with a reddish-purple margin form on the leaves. Spots may later drop out leaving shot-holes. Heavily infected canes are stunted, gray-crusted, dry, crack, and often winter-kill. Black raspberries are very susceptible. See Figure 38A under General Diseases. *Control:* Remove and burn all fruiting canes right after harvest. Plant certified, disease-free plants. Remove old cane "handles" when setting plants. Keep down weeds. Space plants. Destroy badly infected canes when found. Destroy nearby wild brambles. Remove all

weak canes in early spring. Apply lime-sulfur ($\frac{4}{5}$ pint in a gallon of water) as buds begin to swell in early spring. Then apply captan, ferbam, or maneb at about 10-day intervals until berries start to ripen and again right after harvest. See the spray program in the Appendix (Table 10). Resistant raspberry varieties: *Blacks* — Blackhawk, Dundee, Evans, Quillen; *Purples* — Marion, Potomac, Sodus; *Reds* — Cuthbert, Indian Summer, Latham, Newburgh, Ohta (Flaming Giant), Ranere, and Turner. Check with your nurseryman or extension horticulturist regarding varieties adapted to your area.

2. *Spur Blight* — General. Mainly on red raspberry. Chocolate-brown, dark blue or purplish-brown spots and encircling bands on the petioles and new canes. Affected areas are gray by fall. Canes are girdled. Laterals often wither and die early in the season. Spreading, brown, angular blotches occur on the leaves. Such leaves wither and drop early leaving the canes bare. Buds turn brown, shrivel, and die or produce yellowish leaves. See Figure 157. *Control*: Same as for Anthracnose (above). Resistant raspberries: Chief, Columbian, Marcy, Ontario, and Viking. Check with your nurseryman or extension horticulturist regarding varieties adapted to your area.
3. *Cane Blights, Dieback* — General. Fruiting canes usually wilt, wither, and die be-

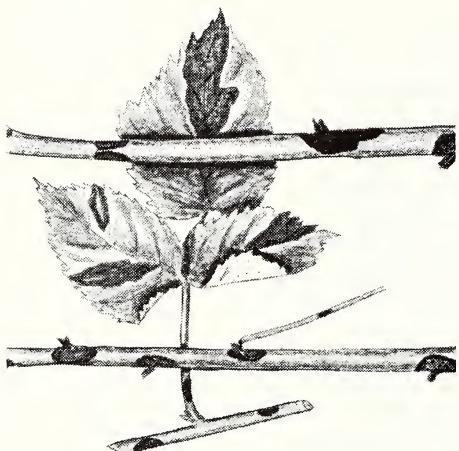


Fig. 157. Spur blight of red raspberry.



Fig. 158. Raspberry cane blight. (Iowa State University photo)

tween blossoming and fruit ripening. Gray, black-dotted, flattened cankers on the canes. Canes become cracked, brittle; easily break off. See Figure 158. *Control*: Same as for Anthracnose (above). Fertilize and prune to keep plants vigorous. Prune at least 3 days before rain is predicted. Avoid wounding new canes. Control insects using malathion and methoxychlor sprays. Columbian is a resistant purple raspberry.

4. *Crown and Root Gall, Cane Gall, Hairy Root* — General and serious. Rough, warty, white to black overgrowths or galls on the roots, crown, and lower parts of the canes. Bark may split open and dry out. Plants often stunted, lack vigor, gradually die. Berries are seedy. See Figure 44C under General Diseases. *Control*: Plant certified, disease-free plants in clean soil. Carefully dig up and burn all infected plants when first noticed. Avoid replanting in the same area for 3 or 4 years without first drenching the soil with Vapam or V.P.M. Soil Fumigant. Avoid injuring plants.
5. *Virus Decline* (mosaics, mottle, leaf curls, rosette or streak, necrosis, dwarf) — General and serious. Symptoms variable. Plants decline in vigor. Never recover. Leaves



Fig. 159. Raspberry leaf curl.

Fig. 160. Orange rust of blackberry.

may be yellowish, light green to dark green, mottled, dwarfed, curled, wrinkled, and cupped downward. See Figure 159. Plants may be slightly to greatly stunted with dark green, bunchy, stiff, tightly curled leaves. Or foliage may be sparse with spindly canes. Fruit production gradually decreases over several years. Fruit often dry, seedy, and small. Canes may be brittle. Dark blue or bluish-violet spots or stripes may develop on the canes near the base (Streak). *Control:* Plant certified, disease-free plants. Dig up and burn infected plants when first found. Destroy nearby (within 500 feet if possible) wild brambles before setting out new plants. Control aphids which transmit certain viruses, using malathion or nicotine sulfate. Resistant *raspberries* to one or more viruses: Indian Summer, Latham, Marcy, Milton, Newburgh, September, Taylor, Viking, and Washington.

6. *Fruit Rots* — Cosmopolitan. Berries rot. Often soft and watery or may shrivel and become hard. Rotted areas may be covered with a gray, tan, or black mold. *Control:* Handle fruit carefully to avoid bruising. Pick early in the day. Discard rotten, overripe, sunburned, or imperfect berries. Refrigerate promptly. Apply captan alone as berries start to color and just before harvest, especially if the period is wet.
7. *Orange Rusts* — General. Underside of leaves is covered with bright, reddish-orange, dusty pustules in late spring. Leaves may wither and drop early. See Figure 160. New shoots are spindly or stunted with dwarfed or misshapen yellowish-green leaves. Infected plants never recover. Produce no fruit. Red raspberry and boysenberries are highly resistant. *Control:* Plant only certified, disease-free plants. Carefully dig up and burn infected plants when first seen, and before the pustules break open. Be sure to remove or kill the roots. Keep down weeds. Destroy nearby wild brambles. Spray as for Anthracnose (above). Resistant *blackberries*: Boysen, Ebony King, Eldorado, Evergreen, Lawton, Lucretia, Russell, Snyder, and Young.

8. *Yellow Rusts, Leaf and Cane Rusts* — General. Small, lemon-yellow to orange, dusty pustules on both leaf surfaces, stems (canes), and petioles. Pustules may be dark brown or black late in the season. Leaves are curled, later wither and drop early. Alternate host is white spruce or none. *Control:* Same as for Anthracnose (above). Varieties differ greatly in resistance to these rusts.
9. *Verticillium Wilt, Blue Stem* — New shoots are stunted, wilt, may turn bluish-black and die. Leaves are dull green then yellow to brown. Cup downward and fall early. Disease progresses upwards from the base. Fruits dry up before ripening. Broad, bluish-black streaks, extending from the base upwards, appear on older canes. Black raspberries are very susceptible. Plants gradually decline. See Figure 30D under General Diseases. *Control:* Plant certified, disease-free plants in well-drained soil where wilted eggplant, tomato, potato, strawberry, or raspberry plants have not occurred before. Dig up and destroy infected plants when found. Do not re-plant susceptible plants in the same soil for several years without first fumigating with Vapam, V.P.M. Soil Fumigant, or chloropicrin (pages 440-44). Resistant *blackberries*: Burbank Thornless, Cory, Evergreen, Himalaya, Logan, Mammoth, and Thornless. Dewberry is rarely infected.
10. *Leaf Spots, Cane Spot* — General. Small, round to irregular spots of various colors occur on the leaves and canes. Infected leaves may wither and drop early, usually starting at the base of the cane. Canes may be stunted and weakened. Yield is often reduced. *Control:* Same as for Anthracnose (above). After harvest apply three or four sprays, 2 to 3 weeks apart, using captan, ferbam, zineb, fixed copper, or bordeaux mixture (4-4-50). Carolina, Evergreen, Himalaya, and Lucretia *blackberries* have resistance to *Septoria (Mycosphaerella, Sphaerulina) Leaf Spot*, as do Dixie Mandarin and Van Fleet *raspberries*.
11. *Root Rots, Collar Rot* — Plantings decline in vigor. Plants may die. Roots decay. Most serious in heavy, wet soils. See under Apple and Currant. May be associated with nematodes (e.g., dagger, lance, pin, ring, root-lesion, sheath, spiral, stem, stubby-root, stylet or stunt).
12. *Powdery Mildews* — Common but usually a minor problem. White powdery growth on the leaves, tips of new canes and even the fruit. Leaves are dwarfed, mottled, and distorted. Cane growth is stunted. Yield may be reduced. Most commercial varieties of red raspberry and dewberry are highly susceptible as is Blackhawk black raspberry. *Control:* Space plants and prune for good ventilation and sunlight. Keep down weeds. Cumberland and Logan *raspberries* have resistance. Most *blackberries* appear to be resistant. Apply a dormant or delayed dormant spray of lime-sulfur (see Table 10 in the Appendix). Spray with Karathane when mildew is first seen.
13. *Winter Injury* — Symptoms variable. Entire plants may die during the winter or up to harvest. Tips of canes die back or buds are killed. Berries may be irregular and aborted. The presence of other diseases frequently increases the severity of winter injury. *Control:* Practice recommended cultural practices for your area, e.g., mulching, fertilizing, and pruning. Provide for sturdy, mature wood in autumn. Prune out dead and injured canes. Control diseases and insects by following the spray program given in the Appendix (Table 10).
14. *Sunscorch* — Ripening fruit are gray and dull. *Control:* Follow recommended cultural practices. Same as for Anthracnose (above).
15. *Male Berry (blackberry sterility)* — New canes developing from affected plants are more vigorous. Eldorado and older varieties are quite susceptible. *Control:* Destroy affected plants, including all the roots. Do not start new plantings from "diseased" plants. Grow "immune" varieties of blackberries (e.g., Bailey, Ebony King, and Hedrick).
16. *Sooty Blotches, Black Mildew* — See (12) Sooty Mold under General Diseases. *Control:* Apply malathion and methoxychlor to control insects.

17. *Downy Mildew* — See (6) Downy Mildew under General Diseases.
18. *Fire Blight, Flower and Twig Blight* (raspberry) — See (24) Fire Blight under General Diseases.
19. *Chlorosis* — See under Maple and Walnut. Mostly in western states in alkaline soils. Due to a deficiency of one or more essential nutrients.
20. *Thread Blight* — Southeastern states. See under Walnut.

RATIBIDA — See **Chrysanthemum**

REDBAY — See **Avocado**

REDBUD, RED - CARDINAL — See **Honeylocust**

REDCEDAR — See **Juniper**

RED HAW — See **Apple**

REDHOT - POKERPLANT or POKER - PLANT, TORCHLILY (*Kniphofia, Tritoma*)

1. *Root-knot* — See (37) Root-knot under General Diseases. *Control:* Indoors grow plants in sterilized soil in sterilized containers. See "Soil Treatment Methods and Materials" in the Appendix.
2. *Leaf Spot* — Small dark spots on the leaves. *Control:* Pick off and burn spotted leaves. Indoors keep water off the foliage.

RED - ROBIN — See **Cranesbill**

RED - VALERIAN — See **Valerian**

REDWOOD — See **Pine**

RESEDA — See **Mignonette**

RETINOSPORA — See **Juniper**

RHAMNUS — See **Buckthorn**

RHEUM — See **Rhubarb**

RHEXIA — See **Deergrass**

RHODODENDRON [CAROLINA, CATAWBA, COAST, DAHURIAN, KOREAN, Piedmont, ROSEBAY or GREAT LAUREL], AZALEA [AMOENA, FLAME, GHENT, GLENN DALE, INDIAN, JAPANESE, KAEMPFERI, KAEMPFERI HYBRID, KURUME, KURUME HYBRID, MACRANTHA, MOLLIS or CHINESE, PINKSHELL, ROYAL, SNOW, SWAMP, SWEET or SMOOTH YELLOW], PINXTERBLOOM, DOWNY PINXTERBLOOM, RHODORA (*Rhododendron*)

1. *Leaf Spots, Leaf Scorch or Blotch, Anthracnose, Spot Anthracnose, Tar Spot, Blight* — General. Small to large, round to angular or irregular, spots and blotches on the leaves. Often found on leaves damaged by frost, winter injury, sunscald, or insect injury. Spots may be silvery-white, yellow, gray, tan, red, reddish-brown, or dark brown in color. May be zonate with a conspicuous margin. Centers often sprinkled with black dots or possibly mold growth. Leaves may drop prematurely. See Figure 161. *Control:* Grow only varieties adapted and recommended for your area. Varieties differ in resistance. Check with your local nurseryman, county agent, or extension horticulturist. Grow plants in partial shade, sheltered from strong, dry, winter winds. Keep the soil well mulched with peatmoss, oak leaves, pine needles, or leaf-mold. The soil should be well-drained, acid (pH 4.5 to pH 5.5), and high in or-

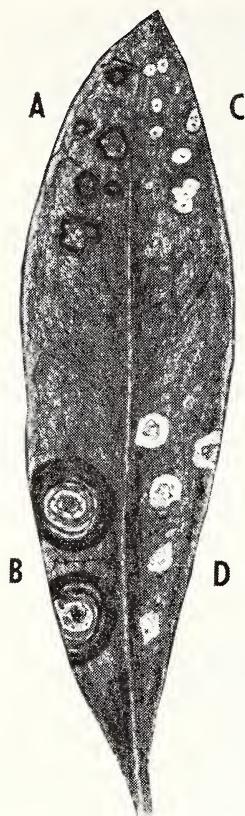


Fig. 161. Rhododendron leaf spots. A. Cercospora, B. Phomopsis, C. Phyllosticta, D. Exobasidium. All 4 types of spots would never be found on the same leaf.

ganic matter. Water during summer droughts. Be sure plants get the equivalent of an inch of rainfall every 10 days. Control insects with a mixture of DDT or lindane and malathion. Spray with captan, zineb, ziram, ferbam, or fixed copper at 10-day intervals as leaves are expanding, and again just after flowering. Sprays may also be needed during the summer or fall where humid and moist. Add about $\frac{1}{2}$ teaspoonful of household detergent or commercial spreader-sticker to each gallon of spray. May combine with sprays to control insects. For additional information on "Growing Azaleas and Rhododendrons," get a copy of USDA Home and Garden Bulletin No. 71.

2. *Winter Injury, Leaf Burn* — General where plants are grown near the limit of hardiness. Margins and tips of leaves turn brown in March or April. *Control:* Same cultural practices as for Leaf Spots (above).
3. *Chlorosis, Yellow Leaf* — General in neutral and alkaline soils, and next to brick or concrete foundations. New leaves are yellowed except for the main veins. See Figure 79. If uncorrected, next year's flower buds may not form. Cold injury is often mistaken for a nutrient deficiency. *Control:* Make the soil acid as given under Root and Stem Rots (below). For immediate relief apply sprays containing ferrous (iron) sulfate (1 ounce per gallon of water), ferbam (3 tablespoons per gallon), or iron chelate following the manufacturer's directions. Repeat sprays as needed.

4. *Root and Stem Rots, Wilt, Dieback, Twig Blights* — Widespread. Leaves may be dull yellowish-green or water-soaked, then wilt and wither from a brown to black rot of the lower stem and roots. Or terminal buds and leaves turn brown, roll up, and droop. Brown, sunken, girdling cankers may form on the stem. Roots may decay. All parts above the canker or rot later wilt and die. Rhododendron varieties differ in susceptibility. May be associated with nematodes (e.g., dagger, lance, pin, ring, root-knot, root-lesion, sheath, sheathoid, spiral, stem, sting, stubby-root, stunt or stylet). *Control:* Same as for Leaf Spots (above). Avoid overwatering. Maintain an acid soil ranging between pH 4.5 and pH 5.5 by adding sulfur, acid fertilizer, aluminum sulfate, or acid peatmoss (page 16). Check with your local nurseryman or extension horticulturist. Avoid wounding roots or stems and overwatering. Prune out and burn infected parts making cuts several inches below the brown canker. Remove and burn severely infected plants together with surrounding soil. Avoid planting close to lilacs. Sterilize the soil (pages 437-44) before planting.
5. *Flower Spot, Petal or Limp Blight* (primarily azalea) — Serious in southern states, especially near the coast. Indian and Kurume azaleas are very susceptible. Small,

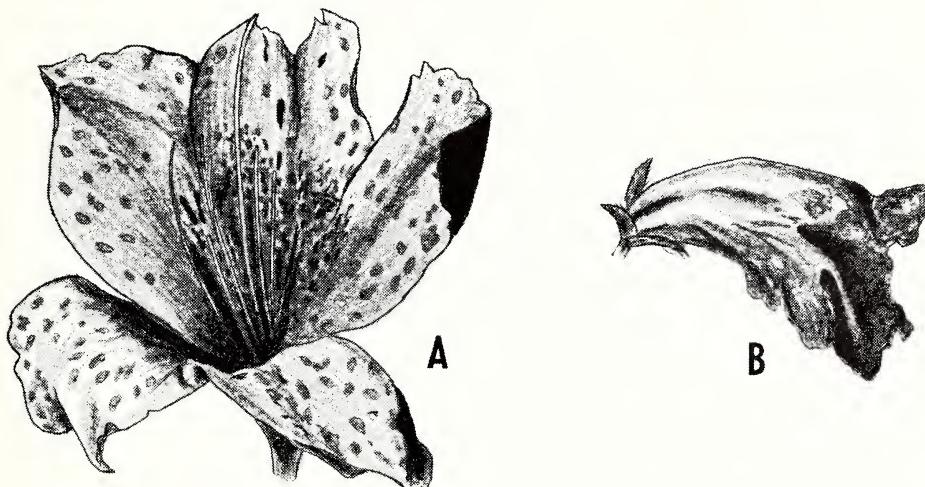


Fig. 162. Azalea flower spot or limp blight. A. Early stage of the disease, B. Later stage.

pale, round spots form on the underside of the flower petals. The spots are white on colored flowers and tan to brown on white flowers. When moist the spots enlarge rapidly and run together forming large, irregular blotches. The flowers quickly go brown, limp, and mushy. See Figure 162. Rotted flowers are covered with a whitish mold. *Control:* Space plants. Grow where air circulation is good. Where practical, pick off and burn spotted flowers when first seen. Apply a light, misty spray 2 to 4 times weekly, during wet weather. Start a week before flowering and continue during the bloom period. Use zineb, thiram (Thylate), Acti-dione, or manebe. Thylate (1 tablespoon per gallon) leaves less residue on the flowers than other materials. Special azalea kits are sold where this disease is prevalent. Apply Acti-dione RZ or Terraclor directly to the soil, under and around azalea plants, 4 to 6 weeks before bloom is expected. Follow the manufacturer's directions. Then replace mulch with fresh material. Do not buy azaleas from the South unless plants have bare roots. Before planting, remove and burn any buds showing color.

6. *Bud Blast and Twig Blight* — Widespread. Scales of terminal flower buds turn silvery-gray and are sprinkled with tiny black "bristles." Later the flower and leaf buds rot, shrivel, and turn light to dark brown in color. Such buds remain on the stem for 2 or 3 years; form rosettes. Twigs may die preventing flowering the next year. *Control:* Prune and burn infected buds and twigs when first seen. Remove and burn faded flower clusters. Destroy seedpods after blooming. Spray as for Leaf Spots and Flower Spot (above).
7. *Leaf, Shoot and Flower Galls, "Rose Bloom," Witches'-broom* — General. Leaves may be spotted with yellow or red, or turn light green or whitish and thickened, wholly or in part. The leaf surface may be deformed, blistered, (bladder-like) and curled. Whole flowers, individual petals, or seedpods may turn into thick, hard, waxy, irregular galls. The surface of affected parts becomes covered with a white to pink powdery bloom. Galls later turn brown and hard. Fleshy rosettes of leaves may be formed at the tip of a branch. *Control:* Hand pick and burn galls when first evident and before they turn white. Otherwise spray once before the leaves unfurl using bordeaux (3-1-50), fixed copper, ferbam, or zineb (4 tablespoons per gallon) plus a spreader-sticker. Repeat 2 to 3 weeks later. Propagate from disease-free plants. Varieties differ in susceptibility. Spray after bloom as for Leaf Spots (above).
8. *Witches'-broom* — Distinct witches'-brooms are produced on coast rhododendron and rhododendron hybrids. Leaves turn yellowish-white and become covered with a dense, mealy growth on the undersurface. *Control:* Destroy infected plants since the fungus is systemic within the plant.
9. *Damping-off, Cutting Rots, Crown Canker* — General. A serious nursery disease in cutting beds. Stems soften and rot at the soil line. Leaves may darken and drop early. *Control:* Increase air circulation and light. Avoid overcrowding and overwatering. Plant seeds in a sterile medium (e.g., sifted sphagnum moss). Sterilize the soil (pages 437-44) or drench before planting using a mixture of Terraclor and phaltan or captan. Follow the manufacturer's directions.
10. *Powdery Mildews* — White, powdery mold patches develop on the leaves in late summer. *Control:* Spray with sulfur or Karathane when mildew is first evident. Repeat as necessary.
11. *Rusts* — Eastern states and Pacific Northwest where plants are growing near the alternate hosts, hemlock and spruce. Bright yellow to brownish, powdery pustules on the underside of the leaves. *Control:* Avoid planting near the alternate hosts. Spray as for Leaf Spots (above) using ferbam, maneb, or zineb.
12. *Crown Gall* — Uncommon. Stem base of young plants is swollen. See (30) Crown Gall under General Diseases.
13. *Verticillium Wilt* — Uncommon. See under Maple, and (15B) Verticillium Wilt under General Diseases.
14. *Thread Blights* — Southeastern states. See under Walnut.
15. *Sooty Mold* — See (12) Sooty Mold under General Diseases. Common on shrubs growing under tuliptree and other trees attacked by aphids, scales, mealybugs, whiteflies, and other insects.

RHODORA — See Rhododendron

RHODOTYPOS — See Jetbead

RHOEA, PURPLELEAF SPIDERWORT, MOSES - IN - A - BOAT (*Rhoea*)

1. *Root Rot, Crown Rot* — See under African-violet.
2. *Root-knot* — See under African-violet.

RHUBARB (*Rheum*)

1. *Root and Crown Rots, Southern Blight, Damping-off* — Widespread. Leaves may turn yellow, wilt, and collapse from a rot of the stalk bases, crown and roots. Brownish-black streaks may occur in the lower ends of the stalks. Mold growth may cover affected tissues in damp weather. Often associated with nematodes (e.g., cyst, dagger, root-knot, spear, spiral, stem-rot, stylet or stunt). *Control:* Plant healthy roots from disease-free fields or beds in well-drained, clean soil. Or soil fumigated with formaldehyde, Vapam, chloropicrin, etc. See "Soil Treatment Methods and Materials" in the Appendix. Spray the crowns early in the spring and again after harvest with fixed copper or bordeaux mixture. Dig up and destroy all infected plants together with 6 inches of surrounding soil. Five- to 6-year rotation. Avoid a wet mulch.
2. *Leaf and Stalk Spots and Blights, Anthracnose, Gray-mold Blight* — Widespread. Round to irregular, variously colored spots on the leaves and stalks. Spots may enlarge and blight the leaf or fall out leaving ragged shot-holes. Leaves may wilt, wither, and die. *Control:* Collect and burn the tops in late fall. During harvest pick stems with spotted leaves first. If serious enough, apply captan, thiram, ferbam, manebe, phaltan, or fixed copper at 10-day intervals during damp periods. Avoid applications from 10 days before harvest until cutting is completed. Apply fertilizer in the spring and again after harvest. Varieties differ in resistance. Set out disease-free roots in an area where rhubarb has not grown for at least 3 years. Avoid over-crowding.
3. *Stalk Rots, Bacterial Soft Rots* — Soft and brown or slimy, foul-smelling rot of the stalks in field or after harvest. *Control:* Same as for Leaf Spots (above). Avoid wounding stalk bases.
4. *Ringspots, Mosaic* — Pale yellowish to dead spots or rings on the leaves, usually with a pale green mottle. Young leaves show a well-defined to severe light and dark green mosaic mottle. Leaves are often crinkled and distorted. Symptoms may disappear in hot weather. *Control:* Dig up and destroy infected plants. Plant virus-free stock. Control aphids which transmit the viruses. Use lindane or malathion.
5. *Curly-top* — Western states. See (19) Curly-top under General Diseases. No very characteristic symptoms are formed. *Control:* Same as for Ringspots (above). The virus is spread by leafhoppers.
6. *Crown Gall* — See (30) Crown Gall under General Diseases.
7. *Root-knot and Cyst Nematode* — See (37) Root-knot under General Diseases.
8. *Verticillium Wilt* — Plants gradually wilt, wither, and die. See (15B) Verticillium Wilt under General Diseases.
9. *Bacterial Wilt, Southern Wilt* — See (15C) Bacterial Wilt under General Diseases.
10. *Rust* — Uncommon. Large, carmine-red spots on the upper leaf surface and tiny, whitish, cluster cups on the underleaf surface. Alternate host: common reed grass (*Phragmites*) which grows in swamps and wet areas. *Control:* Same as for Leaf Spots (above).
11. *Downy Mildew* — Small to large, brown spots on the upper leaf surface. A whitish to violet-colored mold appears on the corresponding underleaf surface in cool, damp weather. *Control:* Plant healthy roots in soil which has not grown rhubarb for at least 3 years. Spraying may be needed in cool, wet weather. Apply zineb, fixed copper, or bordeaux mixture (4-4-50) at weekly intervals starting when the leaves begin to expand.
12. *Cracked Stem, Boron Deficiency* — See under Celery.

RHUS — See **Sumac**

RIBES — See **Currant**

RICINIS — See **Castor - bean**

RIVINA — See **Rougeplant**

ROBINIA — See **Honeylocust**

ROCHEA — See **Crassula**

ROCKCRESS, ROCKET — See **Cabbage**

ROCKJASMINE — See **Primrose**

ROCKSPIREA — See **Holodiscus**

ROCKY MOUNTAIN GARLAND — See **Fuchsia**

ROLLINIA — See **Pawpaw**

ROMANZOFFIA — See **Phacelia**

RORIPPA — See **Cabbage**

ROSARYPEA — See **Pea**

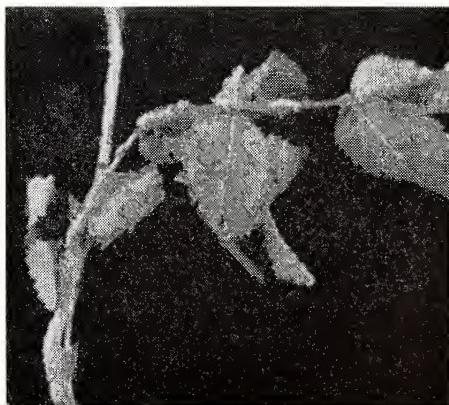
ROSE [**BRIER, BRISTLY or GLOSSY - LEAVED, BURNETT, CAROLINA, CHINA or BENGAL, EVERGREEN, FAIRY, FLORIBUNDA or POLYANTHA, GRANDIFLORA, HYBRID PERPETUAL or REMONTANT, HUGO ROSE or GOLDEN ROSE OF CHINA, HYBRID TEA, JAPANESE, KOREAN, MINIATURE, MULTIFLORA, MUSK, PERPETUAL BRIER or RUGOSE, PRAIRIE, PRIMROSE, RAMBLER, SHRUB, SETIGERA HYBRIDS, SWEET BRIER or EGLANTINE, TEA, and WICHURIANA or MEMORIAL] (Rosa); **GOATSBEARD** (Aruncus); **COWANIA**; **MOCK - STRAWBERRY** (Duchesnea); **MEADOWSWEET, QUEEN - OF - THE - MEADOW, QUEEN - OF - THE - PRAIRIE, DROPWORT** (Filipendula); **AVENS** (Geum); **OSOBERRY** (Osmaronia); **CINQUEFOIL** (Potentilla); **BURNET** [**AMERICAN, JAPANESE, SITKA**] (Sanguisorba)**

1. **Rose Blackspot** — General and serious on susceptible varieties. Roundish black spots with irregular or frayed margins on the leaves. Small black or purplish-red spots also occur on the young shoots and petioles. Infected leaves often turn yellow and fall early, weakening the plants. Defoliated plants are more susceptible to winter injury and drought. Blooming is reduced. See Figure 15C under General Diseases. *Control:* Buy best-quality, disease-free plants from a reputable nursery. Prune and burn old canes before growth starts in the spring. Indoors keep water off the foliage.
- **Rose varieties** differ greatly in resistance. Check with your local nurseryman, rose grower, or extension horticulturist. Apply a dormant spray of lime-sulfur (1 part in 10 parts of water) before growth starts in the spring. Apply captan, phaltan, zineb, or maneb weekly throughout the season. Spraying is more effective than dusting. Cover the underside of leaves thoroughly. Collect and burn fallen leaves where practical. Space plants. Mulch plants throughout the growing season. Control insects and mites using a mixture of DDT or methoxychlor plus malathion. These materials can be mixed safely with the fungicides listed.
2. **Powdery Mildews** — General and serious. Whitish-gray, powdery, mealy coating on the leaves, flower buds, and young stems. Causes stunting, reduced vigor, and blooming. Cane tips and flower buds may be distorted and killed. Leaves curl,

turn reddish or purplish, wither, and drop early. Most rose climbers, small-flowered ramblers, and some of the new floribundas are very susceptible. See Figure 21B under General Diseases. *Control:* Grow resistant rose varieties where possible. Check with a local nurseryman, a top rose grower, or your extension horticulturist. Space and prune plants properly. Apply the same dormant spray as for Blackspot (above). Apply phaltan, sulfur, or Karathane with Blackspot sprays or dusts, or use Actidione alone following the manufacturer's directions. Do not apply sulfur, Karathane, or Actidione if the temperature is above 85° F. Avoid overfertilizing, especially with nitrogen.

3. *Rose Stem Cankers, Dieback, Cane Blight, Spot Anthracnose* — General and serious. Stems die back from pruning cuts, graft unions, and flower stalk stubs due to light brown to black cankers. Cankers may start as small white, red, dark reddish, or purple spots. Several cankers develop cracks and are sprinkled with black dots, the fruiting bodies of the causal fungi. Cankers often girdle the stems causing the foliage beyond to wilt and die. Entire plant may be killed. See Figure 38B under General Diseases. *Control:* Plant only highest quality, disease-free plants from a reputable nursery. "Cut-rate" plants are often infected. Prune out and burn cankered canes as soon as found. Make clean cuts 3 to 4 inches behind the canker but close to a bud. See Figure 7. Dip or swab pruning shears or knife in 70 per cent denatured alcohol between cuts. Cover pruning or other wounds with tree wound dressing (page 25). Spray as for Blackspot (above). Keep plants in a healthy, actively-growing condition. Cut off old flowers. Do not fertilize plants late in the season. Indoors plant in sterilized soil.
4. *Rose Crown Gall, Stem Gall, and Hairy Root* — General. Small to large rough galls or overgrowths on the roots, crown, and canes, usually near the soil line or graft union. Plants are often stunted and lack vigor. Flowering is reduced. See Figure 44B under General Diseases. Hairy Root causes the production of a mass of small fibrous roots giving a witches'-broom effect which may arise from swellings. *Control:* Dig up and burn infected plants. Plant disease-free nursery stock. Do not replant in the same area within 3 years without drenching the soil with Vapam or V.P.M. Soil Fumigant. Do not wound plants. Dip cutting wood in 0.5 per cent calcium hypochlorite (household bleach) for 15 to 20 minutes plus sanitary precautions in handling cuttings. Disinfect benches, sacks, and tools, with commercial formaldehyde, 1 part in 50 of water. Practice strict sanitation.
5. *Rusts* — General. Bright orange-colored, reddish, or orange-brown pustules on the petioles, young canes, underleaf surface, and buds. Pustules later turn dark brown

Fig. 163. Rose rust.



and finally black. Leaves may wilt, wither, and drop early reducing plant vigor. Most hybrid tea and climbing roses are susceptible. See Figure 163. *Control:* Same as for Blackspot (above). Spray with maneb, zineb, ferbam, or sulfur. Plant resistant rose varieties. Prune out and burn infected canes which may be elongated and gall-like.

6. *Winter Injury* (rose) — Canes die back from the tips. Plants may be entirely killed. Varieties differ greatly in susceptibility. *Control:* Plant hardy varieties recommended for your area. Protect for winter following recommended local practices. This may mean piling a cone of soil 8 inches to a foot deep around the base of plants plus adding a loose covering of pine twigs, clean straw, dry seaweed, or coarse sacking. If in doubt, check with your nurseryman, a successful rose grower, your county agent, or extension horticulturist.
7. *Fungus Leaf Spots, Spot Anthracnose* — Widespread. Spots of various sizes, shapes, and colors on the leaves. Often with a distinct border. Spots may drop out leaving shot-holes. Leaves may be distorted and ragged. Plants may be defoliated and weakened. *Control:* Same as for Blackspot (above).
8. *Bacterial Blight or Blast* — Dark brown, sunken spots appear on the petioles and flower stalks. Flower buds die without opening. Follows cold, wet spring weather. *Control:* Prune and burn infected parts.
9. *Verticillium Wilt* (rose) — Individual canes or entire plants gradually or suddenly wilt near blooming time. Brownish to purplish streaks occur inside of canes at the base. Leaves on infected canes may turn yellow, wither, and drop early. Diseased plants may die gradually over a period of several years. *Control:* Dig up and burn infected plants. Use disease-free budwood or plants. Grow in clean, light, well-drained soil. Avoid wounding roots or crowns and replanting in the same area for 5 or 6 years without fumigating the soil first with chloropicrin, Vapam or V.P.M. Soil Fumigant, etc. See pages 440-44 in the Appendix. Manetti rootstock is highly resistant.
10. *Crown and Root Rots* — Plants gradually decline in vigor and die. White fans of fungus growth are often found between the bark and wood. *Control:* Plant disease-free stock in sterilized soil.
11. *Rose Mosaics, Streak, Rosette, Infectious Chlorosis* — Mostly on greenhouse roses. Symptoms differ greatly between varieties depending on the virus or virus strain involved. Many varieties show no symptoms, especially outdoors. Ring, oakleaf, or watermark patterns may develop in some leaves. Irregular, yellow or brown to reddish blotches and patterns may follow along the veins in the leaves. Leaves are often bent and distorted. Plants may be stunted and less vigorous. See Figure 164. *Control:* Do not use diseased plants for propagating. If practical, destroy infected plants. Replant with virus-free stock.
12. *Gray-mold Blight, Botrytis Blight, Blossom Blight, Storage Decay* — Buds turn brown and are blasted. May fail to open. Brown spots develop on the flower petals. Sunken, grayish-black cankers may grow down the stems from infected buds or pruning cuts. Canes turn brown and soften in cold storage. In damp weather a grayish mold may grow on infected tissues. *Control:* Same as for Blackspot (above). Carefully collect and burn infected buds, blossoms, and stems. Nurserymen commonly dust stored roses with a fungicide, e.g., Terraclor or captan, or dip trimmed plants in captan solution (2 tablespoons per gallon). Nurserymen pack roses in boxes lined with polyethylene-coated Kraft paper.
13. *Chlorosis* — Leaves turn pale green or yellow to ivory-colored with the leaf veins remaining green until the last. See Figure 79. Common in alkaline soils. *Control:* Acidify the soil by adding sulfur, ammonium sulfate, or acid peatmoss (page 16).

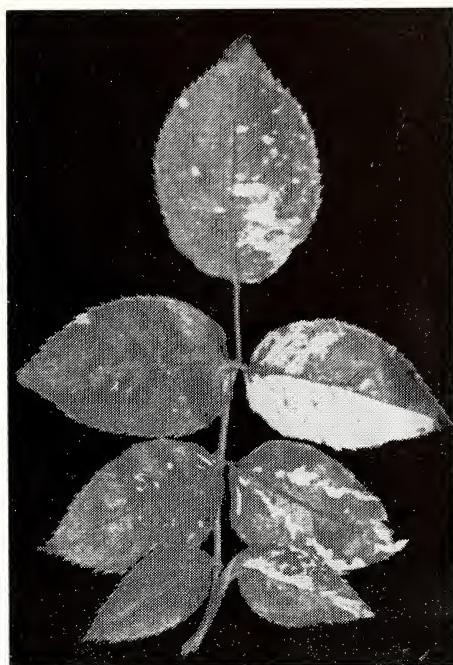


Fig. 164. Rose mosaic.

Work iron sulfate into the soil using 1 to 4 ounces per square foot or use iron chelate following the manufacturer's directions. Water the iron sulfate or iron chelate in well.

14. *Root-knot* — Plants stunted. Produce inferior blooms. Plants sickly with small pale leaves. Small galls or knots are found on the roots. Somewhat similar root galls are produced by dagger nematodes (*Xiphinema* spp.). *Control:* Plant disease-free roses in clean or sterilized soil (pages 437-44). Keep plants vigorous by fertilizing and watering. Protect plants properly for winter. Rose rootstocks vary greatly in resistance.
15. *Root-lesion (Meadow) and other Nematodes* (e.g., dagger, lance, pin, ring, sheath, spiral, stem, sting, stubby-root, stylet or stunt) — General. Plants stunted and may die back. Leaves yellowish. Root system is stunted with roots showing brown areas. May be associated with Hairy Root (above). *Control:* Same as for Crown Gall and Root-knot (both above). Set plants in fumigated soil.
16. *Rose Black Mold* — Primarily a nursery disease. Serious on certain varieties (e.g., Manetti understock, Dr. Huey, and *Rosa odorata*) in grafting cases. Newly infected grafts (stock and scion) are first covered with a white or grayish mold which gradually turns into a black crust. Wood at grafts is discolored. Grafts do not take. Bud unions fail. *Control:* Use only disease-free stock for grafting, or soak 2 hours in a formaldehyde solution (1 part in 320 parts of water). Use resistant or immune rootstocks where possible (e.g., Ragged Robin). Plant in clean soil. Three-year rotation. Practice strict sanitation.
17. *Downy Mildew* (rose, mock-strawberry, avens) — Primarily an indoor problem. Irregular, light to dark spots on the upper leaf surface with a whitish-gray, downy mold growing on the corresponding underside in damp weather. Leaves rapidly turn yellow, wither, and drop. Flowers may be slow or unmarketable. *Control:*

Same as for Blackspot (above). Indoors, keep the humidity below 85 per cent and water off the foliage. Increase air circulation.

18. *Aster Yellows* (avens) — See (18) Yellows under General Diseases.
19. *Leaf Smut* (avens) — See (11) Smut under General Diseases.
20. *2,4-D Injury* — Leaves fernlike and twisted. See under Grape. Rose is very susceptible.
21. *Thread Blight* (rose) — Southeastern states. Plants may be defoliated. See under Walnut. *Control:* Spray as for Blackspot (above).
22. *Crown Rot, Southern Blight* — See (21) Crown Rot under General Diseases.
23. *Fire Blight* (avens, cinquefoil, goatsbeard) — See under Apple.

ROSEBAY — See Rhododendron

ROSELLE, ROSE - OF - SHARON, ROSEMALLOW — See Hollyhock

ROSEMARY — See Salvia

ROSE-MOSS (*Portulaca*)

1. *Damping-off, Seed Rot* — See under Beet, and (21) Crown Rot under General Diseases.
2. *Root-knot* — See (37) Root-knot under General Diseases.
3. *White-rust* — Branches and leaves are swollen and distorted with white pustules. Shoots may be spindly and erect. *Control:* Destroy infected plant parts. Keep down cruciferous weeds. See (9) White-rust under General Diseases.
4. *Curly-top* — See (19) Curly-top under General Diseases.

ROSE - OF - HEAVEN — See Carnation

ROSE TREE OF CHINA — See Peach

ROSINWEED — See Chrysanthemum

ROSMARINUS — See Salvia

ROUGEPLANT (*Rivina*)

1. *Leaf Spots* — Spots of various sizes, shapes, and colors on the leaves. *Control:* Pick off and burn spotted leaves. If practical, spray at 10-day intervals during rainy periods using ferbam, zineb, or maneb. Indoors keep water off the foliage. Space plants.
2. *Rust* — Small, orange-yellow spots on the foliage. Pustules later may become powdery and reddish-brown to a dark chocolate-brown in color. If severe, leaves may wither and die early. *Control:* Same as for Leaf Spots (above).
3. *Root Rots* — See under Geranium, and (34) Root Rot under General Diseases. May be associated with nematodes (e.g., burrowing).

ROWAN TREE — See Apple

ROYSTONEA — See Palms

RUBBER PLANT — See Fig

RUBUS — See Raspberry

RUBY GLOW — See Spirea

RUDBECKIA — See Chrysanthemum

RUE - ANEMONE — See Anemone

RUELLIA — See Clockvine

RUSSIAN - OLIVE, SILVERBERRY, ELAEAGNUS [AUTUMN, CHERRY, THORNY] (*Elaeagnus*) BUFFALOBERRY [RUSSET, SILVER] (*Shepherdia*)

1. *Leaf Spots* — Spots of various colors, sizes, and shapes on the leaves. *Control*: If serious enough, apply zineb or captan at 10- to 14-day intervals during wet, spring weather.
2. *Trunk Canker* — Oval to elongated, sunken cankers which girdle stems and may kill trees. Affected wood under the bark turns brown or black. A gummy brown sap may appear at the margins of some cankers. *Control*: Keep trees free of wounds and growing vigorously. Carefully cut out cankers and all discolored wood. Disinfect wound with household bleach and paint with a tree wound dressing (page 25).
3. *Twig and Branch Cankers, Diebacks* — See under Maple.
4. *Rusts* — Yellowish spots on the leaves. Alternate hosts: *Carex*, *Calamagrostis*, or none. *Control*: Same as for Leaf Spots (above).
5. *Crown Gall, Hairy Root* — See under Apple, and (30) Crown Gall under General Diseases.
6. *Powdery Mildews* (buffaloberry, silverberry) — Powdery, white mold patches on the leaves. *Control*: If serious enough, apply Karathane or sulfur twice 10 days apart.
7. *Verticillium Wilt* — Leaves on certain branches turn yellow, wither, and drop early. A brown discoloration occurs in the wood just under the bark. *Control*: See under Maple.
8. *Thread Blights* — Southeastern states. See under Walnut.
9. *Seedling Blights, Damping-off* — See under Pine.
10. *Root Rot* — See under Apple, and (34) Root Rot under General Diseases.
11. *Wood Rot* — See under Birch, and (23) Wood Rot under General Diseases.
12. *Mistletoe* (*elaeagnus*) — See (39) Mistletoe under General Diseases.

RUSTYLEAF — See Blueberry

RUTABAGA — See Cabbage

RYEGRASS — See Lawnglass

SABAL — See Palms

SAFFLOWER — See Chrysanthemum

SAGE — See Salvia

SAGUARO — See Cacti

ST. - ANDREWS - CROSS — See St. - Johns - wort

ST. AUGUSTINE GRASS—See Lawnglass

ST. - JOHNS - FIRE — See Salvia

ST. - JOHNS - WORT [BUCKLEY, BUSHY, KALMS, MARSH, SHRUBBY],
AARONSBEARD, GOLDFLOWER, SUNSHINE SHRUB (*Hypericum*);
ST. - PETERS - WORT, ST. - ANDREWS - CROSS (*Ascyrum*)

1. *Leaf and Stem Spots* — Spots of various colors, shapes, and sizes on the leaves. Sometimes on stems and flower bracts. Causes little injury, but may be a nuisance. *Control*: Apply zineb or maneb during wet periods. Collect and burn fallen leaves.
2. *Rusts* — General over much of the United States. Pustules vary from yellow to orange in the spring to reddish-brown and finally black, dusty pustules on the leaves late in the season. *Control*: If serious enough, same as for Leaf Spots (above).
3. *Powdery Mildew* (*hypericum*) — See (7) Powdery Mildew under General Diseases.
4. *Root-knot* — See (37) Root-knot under General Diseases.

SAINTPAULIA — See **African - violet**

ST. - PETERS - WORT — See **St. - Johns - wort**

SALAL—See **Heath**

SALIX—See **Willow**

SALMONBERRY— See **Raspberry**

SALPIGLOSSIS — See **Tomato**

SALSIFY — See **Lettuce**

SALVIA, SAGE [**BLUE, GARDE, SCARLET**], **ST. - JOHNS - FIRE** (*Salvia*);
BASILWEED (*Clinopodium*); **COLEUS**; **DITTANY**, **STONEMINT** (*Cunila*);
DRAGONHEAD (*Dracocephalum*); **HYSSOP** (*Hyssopus*);
LAVENDER (*Lavandula*); **LIONS - EAR** or **LIONS - TAIL** (*Leonotis*);
SWEET MARJORAM (*Marjorana*); **HOREHOUND** (*Marrubium*);
BALM (*Melissa*); **MINT, CREEPING MINT, PEPPERMINT, SPEARMINT**
(*Mentha*) **YERBA - BUENA** (*Micromeria*); **BELLS OF IRELAND** (*Molucella*);
BEEBALM, HORSEMINT, LEMON MINT, OSWEGO - TEA, WILDBERGAMOT
(*Monarda*); **MONARDELLA**; **NEPETA, CATNIP, GROUND - IVY** (*Nepeta*);
BASIL [**AMERICAN, SWEET**] (*Ocimum*); **FALSE - DRAGONHEAD**
(*Physostegia*); **SELFHEAL, HEAL - ALL** (*Prunella*); **MOUNTAIN - MINT**
(*Pycnanthemum*); **ROSEMARY** (*Rosmarinus*); **SKULLCAP** (*Scutellaria*);
BETONY, HEDGENETTLE, LAMBS - EARS, WOUNDWORT (*Stachys*);
GERMANDER [**AMERICAN, SHRUBBY**] (*Teucrium*); **THYME,**
MOTHER - OF - THYME or CREEPING THYME (*Thymus*)

1. *Leaf Spots, Anthracnose, Spot Anthracnose, Tar Spot* — Spots of various sizes, shapes, and colors on the leaves. Often with a distinct margin. Some leaves may wither and drop early. Spots may also occur on the stem and rootstocks. *Control*: Pick off and burn infected leaves. If practical, spray during wet periods using zineb, maneb, or captan. Burn tops in the fall.
2. *Root-knot* — Plants may be stunted and sickly with gall-like nodules on the roots. Coleus is highly susceptible. See (37) Root-knot under General Diseases.
3. *Rusts* (basilweed, dittany, germander, leonotis, mint, monarda, monardella, mountain-mint, physostegia, sage, salvia, stachys, yerba-buena) — Yellow-orange, reddish-brown, dark brown or black, dusty pustules on the leaves, stems, and petioles.

Leaves may wither and die early. Young *mint* shoots are swollen, distorted, and twisted in the spring. *Control:* Same as for Leaf Spots (above). Use zineb, maneb, or sulfur. Check with your county agent or extension plant pathologist. Mint roots (rhizomes) for forcing can be soaked in hot water (112° F.) for 10 minutes to destroy the rust fungus.

4. *Crown Rots, Stem Rots, Southern Blight, Damping-off, Cutting Rots* — Seedlings or older plants wilt and collapse from a rot at the soil line. Stem base may be covered with a cottony or gray mold. Cuttings are discolored and rot at the base. *Control:* Start seeds and cuttings in sterilized soil. See pages 437-44 in the Appendix. Avoid overwatering and overcrowding. Plant in well-drained soil. Dig up and burn infected plants and several inches of surrounding soil. Treat soil as for Delphinium, Stem Canker (page 208).
5. *Root and Rhizome Rots* — See under Geranium, and (34) Root Rot under General Diseases. May be associated with nematodes (e.g., lance, needle, ring, root-lesion, sheath, spiral, stubby-root, stylet or stunt).
6. *Mosaic* (primarily coleus and nepeta) — Symptoms differ with the variety. Leaves are mottled light and dark green, puckered, and crinkled. May show small dead spots, ringspots, oakleaf, or other irregular markings. Leaves or entire plants may be stunted and distorted. *Control:* Destroy infected plants. Use disease-free stock or select cuttings from healthy plants.
7. *Verticillium Wilt* (coleus, mint, monarda) — Plants stunted and may be killed. Leaves drop prematurely. See (15B) Verticillium Wilt under General Diseases. Some *peppermint* hybrids are resistant.
8. *Blossom Blight, Gray-mold Blight, Leaf Blight* — Soft brown spots on the flowers, stems, and leaves. Stems may rot and flower clusters often collapse. A gray mold may grow on affected parts in cool, moist weather. *Control:* Cut off and burn infected plant parts. Spray several times during cool, moist weather using captan or zineb.
9. *Downy Mildew* (dragonhead, false-dragonhead, salvia) — See (6) Downy Mildew under General Diseases.
10. *Leaf Nematode* (coleus, salvia) — Brown or blackish blotches on the leaves, bordered by the larger veins. Heavily infested leaves may die from the base upwards. *Control:* See under Chrysanthemum.
11. *Powdery Mildews* (betony, mint, prunella, salvia, skullcap, stachys) — See (7) Powdery Mildew under General Diseases.
12. *Bacterial Leaf Spot* (catnip) — See (2) Bacterial Leaf Spot under General Diseases.
13. *Fusarium Wilt* (catnip) — See (15A) Fusarium Wilt under General Diseases.

SAMBUCUS — See Snowberry

SANCHEZIA — See Clockvine

SANDMYRTLE — See Labrador-tea

SAND - VERBENA — See Four - o'clock

SANDWORT — See Carnation

SANGUINARIA — See Poppy

SANGUISORBA — See Rose

SANSEVIERIA, BOWSTRING HEMP (*Sansevieria*)

1. *Bacterial Soft Rots* — Soft, mushy, foul-smelling rot of the leaves at the soil line. Plants collapse. *Control:* Avoid overwatering and overcrowding. Plant in sterilized soil (pages 437-44). Do not propagate from diseased plants.
2. *Leaf Spots* — More or less circular spots on the leaves. Often with a distinctive border. Spots may dry up and drop out. Leaves are sometimes girdled and killed by the fusing together of several spots. *Control:* Cut out and destroy infected leaves. Indoors, keep water off the foliage and the humidity as low as practical. If needed, spray when the spots are first seen, using zineb, captan, maneb, or fixed copper plus wetting agent.
3. *Root-knot and Root-lesion Nematodes* — Associated with sickly plants. See (37) Root-knot under General Diseases. *Control:* Soak bare-root plants in hot water (122° F.) for 10 minutes. Cool, then plant in clean or pasteurized soil.

SAPINDUS — See **Soapberry****SAPIUM** — See **Castorbean****SARSAPARILLA** — See **Acanthopanax****SASSAFRAS** — See **Avocado****SATIN - FLOWER** — See **Fuchsia****SAWARA - CYPRESS** — See **Juniper****SAXIFRAGE (*Saxifraga*)** — See **Hydrangea****SCABIOSA, PINCUSHION FLOWER, SWEET SCABIOUS (*Scabiosa*)**

1. *Powdery Mildew* — Powdery, white coating on the leaves. *Control:* Space plants. Dust or spray several times, 10 days apart, using sulfur or Karathane.
2. *Stem Rot, Crown Rot, Southern Blight* — See (21) Crown Rot under General Diseases.
3. *Curly-top* — Western states. See (19) Curly-top under General Diseases.
4. *Aster Yellows* — See (18) Yellows under General Diseases.
5. *Root Rot* — See under Geranium, and (34) Root Rot under General Diseases.
6. *Black Ringspot* — See under Cabbage.

SCARBOROUGH - LILY — See **Daffodil****SCARLET EGGPLANT** — See **Tomato****SCARLET PIMPERNEL** — See **Primrose****SCARLET RUNNER BEAN** — See **Bean****SCHEFFLERA**

1. *Leaf Spots* — Small to large, round to irregular, brown spots and blotches on the leaves. Infected leaves may wither and drop early. *Control:* Indoors keep water off the foliage. Outside try spraying during wet periods with zineb, maneb, or captan to which a wetting agent has been added.
2. *Root-knot* — See (37) Root-knot under General Diseases.

- SCHINUS** — See **Sumac**
- SCIZANTHUS** — See **Tomato**
- SCIADOPITYS** — See **Pine**
- SCILLA** — See **Tulip**
- SCINDAPSUS** — See **Calla**
- SCORPIONWEED** — See **Phacelia**
- SCORZONERA** — See **Lettuce**
- SCOTCH BROOM** — See **Broom**
- SCREWPINE (*Pandanus*)**

1. *Leaf Spots* — Small to large spots develop on the leaves, working inward from the margin. *Control:* Prune off infected leaves and spray with fixed copper, zineb, or both. Indoors keep water off the foliage. Destroy badly infected plants.
2. *Burrowing Nematode* — Associated with sickly, declining plants. *Control:* See Root-knot under Peach.

- SCURVY WEED, SEAKALE** — See **Cabbage**
- SCUTELLARIA** — See **Salvia**
- SEA HOLLY** — See **Celery**
- SEAKALE** — See **Cabbage**

SEA - LAVENDER, STATICE (*Limonium*); SEA - PINK, THRIFT (*Armeria*)

1. *Leaf Spots* — Spots of various sizes, shapes, and colors on the leaves. Heavily spotted leaves drop early. *Control:* Pick off and burn affected parts. If serious enough, apply zineb or maneb at 10- to 14-day intervals, starting when the first spots are evident.
2. *Gray-mold Blight, Botrytis Flower Blight* — Brown rotting spots on the shoots and flowers. A gray mold may cover affected parts in damp weather. *Control:* Same as for Leaf Spots (above).
3. *Rusts* — Not very common. Yellow, yellow-orange, reddish-brown, or black powdery pustules on the leaves. *Control:* Destroy affected plants. Spray the remainder as for Leaf Spots (above).
4. *Aster Yellows* — See (18) Yellows under General Diseases.
5. *Root Rot* — See under Geranium, and (34) Root Rot under General Diseases.
6. *Crown Rots* (statice) — Stem rots at or near the soil line. Plants are easily pulled up. Water-soaked spots, which later darken, occur on the leaves and petioles where they touch the soil. *Control:* Suggest soil treatment as for Cabbage Wirestem.
7. *Root-knot, Cyst Nematode* — See (37) Root-knot under General Diseases.
8. *Spotted Wilt, Ringspot* — See (17) Spotted Wilt under General Diseases. *Control:* Destroy infected plants.

- SEA - PINK — See Sea - lavender**
- SECHIUM — See Cucumber**

**SEDM, LIVEFOREVER, STONECROP, WALL PEPPER, WORMGRASS (*Sedum*);
CRASSULA, JADE PLANT (*Crassula*); ECHEVERIA; KALANCHOË or
BRYOPHYLLUM; ROCHEA; HOUSELEEK, HEN - AND - CHICKENS
(*Sempervivum*)**

1. *Stem and Leaf Rot, Crown Rots, Southern Blight, Root Rot, Wilt* — Brown to black, water-soaked areas on the stem, often at the soil line. May extend upwards into the flower stalks and down into the roots. Affected areas may be covered with a dense cottony mold. Tops of plants soon wilt. Plants may die out in patches in warm, humid weather. Roots decay. *Control*: Set disease-free plants in clean, well-drained soil. Avoid overwatering, too deep planting, overfertilizing, and packing the soil too closely around the crowns. Destroy infected plants or plant parts and drench the remainder with zineb (2 tablespoons per gallon). Do not replant in the same area without first sterilizing the soil with heat or chemicals. See pages 437-44 in the Appendix. Spray at weekly intervals during cool, wet weather using zineb or captan.
2. *Rusts* (echeveria, hen-and-chickens, houseleek, liveforever, stonecrop) — Dark, powdery pustules on the leaves. The center leaves of houseleek are unusually long, narrow, erect, and a pale yellow color. Small, dark, reddish-brown pustules break out on both leaf surfaces. Affected plants do not bloom. *Control*: Pull up and burn infected houseleek plants for they will not recover. Apply zineb, maneb, sulfur, or dichlone two to three times 10 days apart on neighboring plants or other hosts.
3. *Root-knot* — See (37) Root-knot under General Diseases.
4. *Leaf Spots, Blotch, Anthracnose* (crassula, liveforever, stonecrop) — Round, dark spots or blotches on the leaves. Leaves may drop quickly. *Control*: Collect and burn fallen leaves. Try spraying as for Rusts when spots first appear. Repeat before rainy periods.
5. *Powdery Mildew* (kalanchoë) — Grayish-white, powdery growth on the leaves. Leaves may wither and drop early. *Control*: Indoors, keep the humidity down and increase both light and air circulation. Avoid overfertilizing. Apply sulfur or Karathane twice, 10 days apart.
6. *Crown Gall* (kalanchoë) — See (30) Crown Gall under General Diseases.
7. *Fusarium Wilt* (sedum) — California. Leaves turn yellow and drop off, starting at the base of the stem. Plant may wither and die. *Control*: Same as for Stem and Leaf Rot (above).
8. *Leaf Nematode* (crassula) — See (20) Leaf Nematode under General Diseases.

SELF - HEAL — See *Salvia*

SEMPERVIVUM — See *Sedum*

SENECIO — See *Chrysanthemum*

SENNA — See *Honeylocust*

SENSITIVE PLANT — See *Pea*

SEQUOIA — See *Pine*

SERVICEBERRY, SERVICETREE, SHADBLOW, SHADBUSH — See *Apple*

SHALLON — See *Heath*

SHALLOT — See *Onion*

- SHAMROCK** — See *Oxalis*
SHASTA DAISY — See *Chrysanthemum*
SHEEP - LAUREL — See *Blueberry*
SHELL FLOWER — See *Gladiolus*
SHEPHERDIA — See *Russian - olive*
SHORTIA — See *Galax*
SHRUB - ALTHAEA — See *Hollyhock*
SHRUB - YELLOWROOT — See *Clematis*
SICANA — See *Cucumber*
SIDA, SIDALCEA — See *Hollyhock*
SILENE — See *Carnation*
SILKGRASS — See *Yucca*
SILK - OAK (*Grevillea*)

1. *Root-knot* — See (37) *Root-knot*, under General Diseases. *Control*: Sterilize potting soil and container before planting. See pages 437-44 in the Appendix.
2. *Dieback, Gum Disease* — See (22) *Stem Blight* under General Diseases. *Control*: Prune out and burn dead or dying parts. Indoors keep water off the foliage.
3. *Root Rot* — See (34) *Root Rot* under General Diseases. *Control*: Same as for *Root-knot*. Avoid overwatering and overfertilizing.

SILKTASSEL - BUSH — See *Dogwood*

SILKTREE — See *Honeylocust*

SILPHIUM — See *Chrysanthemum*

**SILVERBELL [CAROLINA, MOUNTAIN], SNOWDROP-TREE (*Halesia*);
SNOWBELL [FRAGRANT, JAPANESE] (*Styrax*)**

1. *Leaf Spot* — Large, irregular, rusty-brown blotches on the leaves. *Control*: See under *Maple*.
2. *Wood Rot* — See under *Birch*, and (23) *Wood Rot* under General Diseases.
3. *Root-knot* — See under *Peach*, and (37) *Root-knot* under General Diseases.

SILVERBERRY — See *Russian - olive*

SILVER KING — See *Chrysanthemum*

SILVER LACEVINE, DWARF LACE PLANT (*Polygonum*)

1. *Leaf Spots, Tar Spot* — More or less round, gray or black spots on the leaves. Leaves may wither and drop early. *Control*: Pick off and burn infected plant parts. If practical, spray during wet summer weather using zineb or maneb.
2. *Smuts* — Roundish pustules on the leaves and fruit which break open and release black powdery masses. *Control*: Pick off and burn infected parts before the pustules break open. Destroy plants which show smut each year.
3. *Rusts* — General. Small, brown, powdery pustules on the underside of leaves and stems. Pustules later turn black. Alternate hosts include *Geranium*. *Control*: If

serious enough, apply ferbam, zineb, or maneb several times, starting 2 weeks before rust normally appears.

SILVER THREADS (*Fittonia*)

1. *Stem and Root Rot* — Stems and roots decay. Plants are stunted and sickly. Often wilt and collapse. *Control:* Start plants in sterilized soil (pages 437-44). Infected plants may sometimes be cured by immersing them in hot water (120° to 124° F.) for 30 minutes. Use the lower temperature for unhardened plants. After treating, divide the plants or take cuttings and root or plant in a steamed mixture of perlite and peat. Keep water off the foliage.
2. *Leaf Spot* — See (1) Fungus Leaf Spot under General Diseases.
3. *Root-knot* — See (37) Root-knot under General Diseases.

SINNINGIA — See African - violet

SISYRINCHIUM — See Iris

SKULLCAP — See Salvia

SKYROCKET — See Phlox

SLIPPERWORT — See Snapdragon

SMELOWSKIA — See Cabbage

"SMILAX" of FLORISTS — See Asparagus

SMOKETREE — See Sumac

SNAPDRAGON (*Antirrhinum*); SLIPPERWORT (*Calceolaria*); PAINTED - CUP, INDIAN PAINTBRUSH

(*Castilleja*); TURTLEHEAD (*Chelone*); COLLINSIA, BLUELIPS, BLUE - EYED - MARY, CHINESE HOUSES (*Collinsia*); FOXGLOVE [COMMON, YELLOW] (*Digitalis*); LINARIA, TOADFLAX, BUTTER - AND - EGGS, KENILWORTH IVY (*Linaria*); MAURANDYA; MONKEYFLOWER (*Mimulus*); PENSTEMON, BEARD - TONGUE, LAVENDER QUEEN (*Penstemon*); SYNTHYRIS; TORENIA, WISHBONE FLOWER (*Torenia*); MULLEIN (*Verbascum*)

1. *Rusts* (snapdragon, collinsia, Indian paintbrush, monkeyflower, painted-cup, penstemmon, synthyris, toadflax, turtlehead) — General and serious on snapdragon. Small, reddish-brown or chocolate-brown, powdery pustules on the leaves (mostly underleaf surface), stems, and seedpods. Penstemon pustules are yellow. Infected parts may wilt, shrivel, and die. Small weak flowers are produced. See Figure 22A under General Diseases. Alternate hosts: Wild grasses, pines, none, or unknown. *Control:* Space plants. Keep down weeds. Collect and burn the tops in the fall. Plant disease-free seed, cuttings, or transplants. Resistant varieties of *snapdragons* are available, e.g., Alaska, Apple Blossom, Artistic, Campfire, Canary Bird, Copper King, Crimson, Loveliness, Red Cross, Rosalie, Snow Giant, and Yellow Giant. Indoors avoid sprinkling the foliage when watering. Keep the humidity as low as practical. Control insects with malathion sprays. Apply zineb, ferbam, chloranil, dichlone, or maneb at 7- to 10-day intervals. Start when plants are set in the garden.
2. *Gray-mold Blight, Botrytis Blight* — Cosmopolitan in damp areas. Soft brown rot of the leaves, stems, flowers, cuttings, and seedlings. Flower spike may wilt sud-

denly, collapse, and die. A grayish-brown mold may grow on affected areas. *Control:* Collect and burn the tops in the fall. Space plants. Keep down weeds. Cut flower spikes as early as possible. Indoors, control heat, increase ventilation, and keep down the humidity. Apply captan or zineb twice weekly in wet weather. Mix Terraclor 75 per cent (12 ounces per 100 square feet) into the top 4 to 6 inches of soil a week before planting.

3. *Powdery Mildews* — General. White, powdery growth on the leaves, stems, and flower petals. Leaves may be killed progressively upwards starting at the base. *Control:* Spray several times, about 10 days apart, using phaltan, Karathane, Actidione, or sulfur.
4. *Damping-off, Southern Blight, Stem and Root Rots, Wilt* — General. Seedlings wilt, collapse, and die. Older plants may gradually or suddenly turn yellow, wilt, collapse, and die due to a rotting of the roots. Water-soaked, white, yellow, or brown to black cankers may form at or near the soil line. Other plants may be stunted and sickly-looking with decayed roots. A cottony mold may cover infected areas at the soil line. Flower spikes pale and wilt. Flowers collapse. *Control:* Use clean seed or treat with Semesan and plant in clean or sterilized soil (pages 437-44), which is well-drained. Treat foxglove seed by soaking in hot water (131° F.) for 15 minutes. Avoid overwatering and overcrowding. Propagate from disease-free plants. Destroy infected plants and 6 inches of surrounding soil. Drench the soil with Terraclor 75 (12 ounces per 100 square feet) plus either captan or ferbam (1 pound). Indoors, keep water off the foliage and the temperature down. Spray as for Rusts (above). Rotate.
5. *Anthracnose* (primarily snapdragon, foxglove, and toadflax) — Round to angular, somewhat sunken spots on the leaves and stems. Spots may be pale yellowish-green to grayish-white or purplish-brown in color. Numerous black specks may dot the centers of the spots. Affected parts or the entire plant may wilt and die. Seedlings wilt and collapse. *Control:* Same as for Rusts and Damping-off (both above). Pull and burn severely infected plants when found.
6. *Other Leaf Spots, Blights* — General. Small to large spots of various colors, sizes, and shapes on the leaves. Centers may drop out leaving shot-holes. Leaves may wither and cling to the stem or drop early. Similar spots or cankers on the stems may cause rapid wilting and dying. See Figure 165B. *Control:* Same as for Anthracnose (above).
7. *Root-knot* — Snapdragon is highly susceptible. See (37) Root-knot under General Diseases.
8. *Mosaics* (snapdragon, foxglove, penstemon) — New leaves may be puckered, curled, and mottled with yellowish or light and dark green areas. Leaves and plants are stunted. *Control:* Destroy infected plants when first found. Malathion or lindane sprays control aphids which transmit the viruses.
9. *Verticillium Wilt* (snapdragon, foxglove, slipperwort) — Plants wilt slowly or suddenly, starting with certain branches. Lower leaves turn yellow at the margin. Wilt later progresses up the stem. Greenish-brown to purplish-brown discoloration inside the stem near the soil line. See Figure 165A. *Control:* Rotate. Remove infected plants together with surrounding soil. Water as little as possible to obtain good growth.
10. *Downy Mildew* (primarily snapdragon, mullein, and toadflax) — Seedlings and young plants stunted, bunchy, dull green, wilt and die from the top down. Older plants are stunted. Flowering is reduced. Purplish-gray, mealy, mold patches on the underleaf surface and stems in cool, damp weather. Leaves may wither and die. *Control:* Same as for Rusts (above).

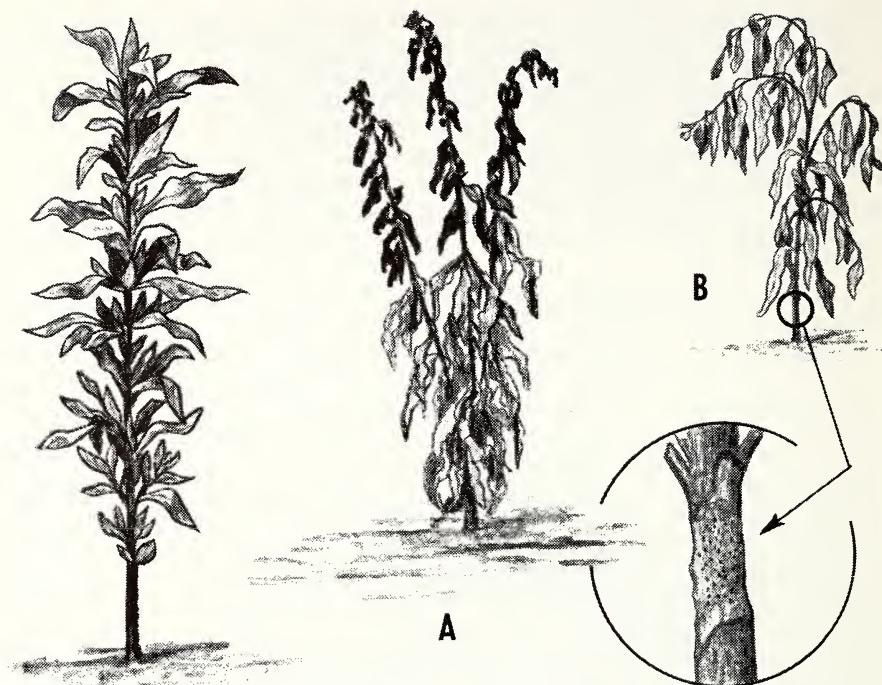


Fig. 165. A. Snapdragon Verticillium wilt, B. Blight or stem rot of snapdragon.

11. *Other Nematodes* (pin, root-lesion or meadow, stylet or stunt) — Plants lack vigor. May be stunted with some dead lower leaves. Feeding roots are stunted and pitted with minute, shallow brown wounds. A laboratory examination is needed for positive identification. *Control:* Same as for Root-knot (above).
12. *Crown Gall* (snapdragon) — See (30) Crown Gall under General Diseases.
13. *Ringspot* (snapdragon) — Numerous zoned rings of alternating living and dead tissue. Whole spots die, then spread and run together with other spots. Whole leaf, then entire plant dies. *Control:* Same as for Mosaics (above).
14. *Spotted Wilt, Ringspot* (snapdragon, foxglove, slipperwort) — Plants may be stunted with rosette-like growth. Leaves are distorted. May show yellow, mosaic-like patterns. Flowers may be marked with pale red or yellow rings. Thrips transmit the virus. *Control:* Same as for Mosaics (above). Use DDT and malathion to control thrips.
15. *Aster Yellows, Curly-top* (foxglove, monkeyflower, toadflax) — See (18) Yellows and (19) Curly-top, under General Diseases. Leaves are curled and dwarfed. Plants become stunted and bunched. Leafhoppers transmit the viruses. *Control:* Same as for Spotted Wilt (above).
16. *Flower Blight* — See under Chrysanthemum, and (31) Flower Blight under General Diseases. *Control:* Same as for Gray-mold Blight (above).
17. *Leaf and Stem Nematode* (butter-and-eggs, foxglove, monkeyflower, slipperwort, toadflax) — Angular brown blotches on the leaves limited by the veins. *Control:*

Keep water off the foliage on indoor plants. Outdoors, apply a dry mulch to keep water from splashing on the leaves. Pick off and burn infested leaves. Burn tops in the fall. Rotate.

18. *White Smut* (butter-and-eggs, *collinsia*) — See (18) *White Smut* under General Diseases.
19. *Black Mildew* (*penstemon*) — See (12) *Sooty Mold* under General Diseases.

SNEEZEWEED — See *Chrysanthemum*

SNOWBALL — See *Viburnum*

SNOWBELL — See *Silverbell*

SNOWBERRY [COMMON, MOUNTAIN, ROUND - LEAF], CORALBERRY or INDIAN Currant, CHENAULT'S CORALBERRY, WOLFBERRY, WAXBERRY (*Symporicarpos*); ABELIA [CHINESE, GLOSSY] (*Abelia*); HONEYSUCKLE [AMUR, BELLE, BLUE - LEAF, BOX, CLAVEY'S DWARF, CORALINE, EUROPEAN FLY -, FLY -, FRAGRANT or WINTER, HALL'S, JAPANESE, JAPANESE PINK, MORROW, PRIVET, STANDISH, SWAMP FLY -, TATARIAN, TRUMPET, WINTER, YELLOW], WOODBINE (*Lonicera*); ELDER [AMERICAN or SWEET, BLUEBERRY, EUROPEAN, EUROPEAN RED, GOLDEN, GOLDEN EUROPEAN, RED - BERRIED, SCARLET] (*Sambucus*); WEIGELA [CRIMSON, ROSE] (*Weigela*)

1. *Leaf Spots, Anthracnose, Scab or Spot Anthracnose* — Widespread. Spots of various sizes, shapes, and colors appear on the leaves. Leaves may become distorted, wither, and drop early. Spots may also occur on the stems, berries, and flowers. Berries shrivel and dry up. Twigs may die back several inches. *Control:* Destroy infected plant parts. Cut diseased snowberry stems to the ground and burn in the fall. Apply zineb, captan, ferbam, dichlone, or fixed copper at 7- to 10-day intervals from when the buds swell to just before bloom. Phenyl mercury is effective against Anthracnose. Follow the manufacturer's directions.
2. *Berry Rots* (snowberry, coralberry) — Widespread. Pink, purple, yellowish, brown, or black spots on the berries. Fruit may become soft, watery, rotted, and covered with a gray or black mold. Or berries may shrivel, dry, and "mummify." *Control:* Spray as for Leaf Spots (above).
3. *Cankers, Twig Blights, Dieback* — Twigs die back. Often caused by rough, girdling cankers on the twigs and branches in which coral-pink to black "pimples" may be embedded. *Control:* Prune out and burn affected twigs and branches. Spray as for Leaf Spots (above).
4. *Honeysuckle Leaf Blight* — Widespread. Irregular, yellowish-green areas in the leaves which soon turn tan and finally a brownish-black. A whitish "bloom" is often evident on the underleaf surface. Leaves roll, twist, wither, and fall early. Only young leaves are infected. *Control:* Same as for Leaf Spots (above). Dwarf type may be resistant.
5. *Rusts* — Small, yellowish or brownish pustules on the upper leaf surface with orange "cluster cups" on the underleaf surface. Alternate hosts may include various wild and lawn grasses, or sedges (*Carex* spp.). *Control:* If serious, apply zineb or ferbam as for Leaf Spots (above).
6. *Collar Rot, Trunk Canker, Wood or Heart Rots* — Plants sickly. Die back from a rot at the soil line. A canker may form on the trunk. *Control:* See under Dogwood, and (23) *Wood Rot* under General Diseases.

7. *Powdery Mildews* — General. White, powdery mold on the leaves and stem tips. Tips of shoots may die back. Snowberry leaves may be distorted. *Control:* Spray with sulfur, Karathane, or Acti-dione several times, 10 days apart.
8. *Crown Gall and Hairy Root* — Rough, irregular, swollen, cauliflower-like galls on the stem at or near the soil line. Plants may appear sickly. *Control:* Dig up and burn affected plants. Do not replant in the same soil for 3 years. Avoid injuring plants when cultivating or mowing. Plant disease-free stock.
9. *Stem Gall* (snowberry, coralberry) — Numerous, small galls may girdle the stems. Parts above the galls may die. *Control:* Prune out and burn affected parts. Spray as for Leaf Spots (above).
10. *Verticillium Wilt* (elder) — See (15B) Verticillium Wilt under General Diseases.
11. *Root Rots* — See (34) Root Rot under General Diseases. May be associated with root-feeding nematodes (e.g., dagger, lance, pin, ring, root-lesion, spiral, stem or rot, sting, stunt or stylet).
12. *Root-knot* — Weigela is very susceptible. See under Peach, and (37) Root-knot under General Diseases.
13. *Leaf Scorch* (primarily golden elder) — Leaves are scorched where unusually hot and windy. *Control:* Plant in a more protected location. Water thoroughly during hot, dry periods.
14. *Chlorosis* — In alkaline soils. See under Maple.
15. *Web Blight, Thread Blight* (elder, honeysuckle) — Southeastern states. See under Bean and Walnut.
16. *Gray-mold Blight* — See (5) Botrytis Blight under General Diseases.
17. *Infectious Variegation* (honeysuckle) — Leaves mottled green and yellow with the veins yellow. See (16) Mosaic under General Diseases.

SNOWDROP — See Daffodil

SNOWDROP - TREE — See Silverbell

SNOWFLAKE — See Daffodil

SNOW - ON - THE - MOUNTAIN — See Poinsettia

SOAPBERRY [CHINESE, FLORIDA, SOUTHERN, WESTERN] (*Sapindus*)

1. *Leaf Spots, Leaf Blight* — Small to large, spots and blotches of various colors on the leaves. *Control:* Collect and burn fallen leaves. Prune to keep shrubs and trees pruned out. Spraying with captan or zineb during rainy periods should be beneficial.
2. *Canker, Dieback* — Twigs die back from discolored, girdling cankers. *Control:* Prune out and burn affected parts. Otherwise same as for Leaf Spots (above).
3. *Powdery Mildew* — Grayish-white, powdery mold growth on the leaves. *Control:* If serious enough, apply two sprays, 10 days apart, using sulfur or Karathane.
4. *Root Rot* — See under Apple, and (34) Root Rot under General Diseases.
5. *Mosaic* — See (16) Mosaic under General Diseases.
6. *Mistletoe* — See (39) Mistletoe under General Diseases.
7. *Thread Blight* — Southeastern states. See under Walnut.

SOAPWEED — See Yucca

SOLANUM — See Potato and Tomato

SOPHORA — See Honeylocust**SORBUS — See Apple****SORRELTREE, SOURWOOD (*Oxydendrum*)**

1. *Leaf Spots, Purple Blotch* — More or less round to irregular, dull red, brown, or purple blotches on the leaves. Centers of spots may later turn brown and dry. *Control:* Collect and burn fallen leaves in autumn. If practical, apply a fixed copper spray when the leaves are fully expanded. Repeat 2 weeks later.
2. *Twig Blight, Dieback* — Rough cankers form on dead and dying twigs and branches. Leaves at the end of affected parts wither and die. *Control:* Avoid injuring trees. Remove and burn dead and dying wood. Fertilize and water to keep trees growing vigorously.
3. *Wood Rot* — See (23) Wood Rot under General Diseases.
4. *Root Rot* — See (34) Root Rot under General Diseases.

SOUR GUM — See Dogwood**SOURWOOD — See Sorreltree****SOUTHERN LEATHERWOOD — See Buckwheat - tree****SOUTHERN WHITE - CEDAR — See Juniper****SPANISH BAYONET — See Yucca****SPARAXIS — See Iris****SPATHOGLOTTIS — See Orchids****SPEARMINT — See Salvia****SPECULARIA — See Bellflower****SPEEDWELL [CATS - TAIL, GERMANDER] (*Veronica*); HEBE;
CULVERSROOT (*Veronicastrum*)**

1. *Leaf Spots* — Common. Small, round spots on the upper leaf surface. May be grayish-violet to brown in color with a purplish margin. Spots may run together forming a leaf scorch. Spots may drop out leaving ragged shot-holes. Leaves wither and drop early. *Control:* Collect and burn fallen leaves. Spray as for Downy Mildew (below).
2. *Downy Mildew* (speedwell) — Widespread. Conspicuous, pale yellowish spots develop on the upper side of leaves with a grayish or purplish mildew forming on the corresponding underleaf surface. *Control:* Spray or dust several times, at weekly intervals or just before wet periods, using zineb, maneb, or fixed copper.
3. *Fusarium Root and Stem Rot, Wilt* — Plants stunted and sickly. Leaves progressively turn yellow and then brown, starting at the base of the plant. *Control:* Dig up and burn infected plants. Avoid replanting in the same area without first sterilizing the soil. See "Soil Treatment Methods and Materials" in the Appendix.
4. *Other Stem and Root Rots* — See under Geranium, and (34) Root Rot under General Diseases. May be associated with nematodes (e.g., root-lesion, spiral, stylet). *Control:* Same as for Fusarium Root and Stem Rot (above).
5. *Powdery Mildews* — Powdery, white mold growth on the leaves and shoots. When severe, young leaves and shoots turn pale and wither. *Control:* Spray or dust using sulfur or Karathane.
6. *Leaf Smut* — See (11) Smut under General Diseases.

7. *Aster Yellows* — Plants yellowish. Produce numerous secondary shoots. *Control:* Destroy affected plants. Keep down weeds. Control leafhoppers which transmit the virus. Use DDT and malathion.
8. *Root-knot* — See (37) Root-knot under General Diseases.
9. *Rusts* — See under Chrysanthemum, and (8) Rust under General Diseases.

SPHAERALCEA — See Hollyhock

SPICEBUSH — See Avocado

SPICELILY — See Centuryplant

SPICEWOOD — See Calycanthus

SPIDERFLOWER (*Cleome*)

1. *Leaf Spots* — Spots of various sizes, shapes, and colors on the leaves. Leaves may wither and drop early. *Control:* See under Chrysanthemum.
2. *Rust* — See under Chrysanthemum, and (8) Rust under General Diseases. Alternate hosts include wild grasses.
3. *Curly-top* — Plants are stunted. Do not flower normally. *Control:* Destroy infected plants. Control leafhoppers which transmit the virus. Use DDT and malathion.
4. *Root-knot* — See (37) Root-knot under General Diseases.
5. *Downy Mildew* — See (6) Downy Mildew under General Diseases.

SPIDERLILY — See Daffodil

SPIKE - PRIMROSE — See Fuchsia

SPINACH, SPINACH - BEET (*Spinacea*) — See Beet

SPINDLETREE — See Bittersweet

SPIREA [ANTHONY WATERER, AZURE BLUE, BILLIARD'S, BLUE MIST, BRIDAL WREATH or PLUMLEAF, FROEBELI, GARLAND, KOREAN, LILAC, NIPPON, REEVE'S, RUBY GLOW, SNOW - BANK, THREELOBE, THUNBERGII (THUNBERG'S), VANHOUTTEI (VAN HOUTTE), VEITCHI], HARDHACK, MEADOWSWEET (*Spiraea*)

1. *Powdery Mildews* — Widespread, especially where humid and wet. White powdery mold on young leaves and shoots. Flowers may be distorted and blasted. Leaves may wither and die. *Control:* When mildew is first seen, apply sulfur or Karathane. Repeat 10 days later. Do not use when the temperature is 85° F. or above.
2. *Leaf Spots* — Spots of various sizes, shapes, and colors on the leaves. *Control:* Collect and burn leaves in the fall. Keep plants open by annual pruning. Apply zineb, captan, or maneb sprays at 10- to 14-day intervals during rainy periods.
3. *Fire Blight* — Blossoms blackened. Shoots die back from the tip. Foliage appears wilted and dark brown or black. The dead leaves tend to cling to the shoots. *Control:* See under Apple.
4. *Crown Gall and Hairy Root* — See under Apple, and (30) Crown Gall under General Diseases.
5. *Root-knot* — See (37) Root-knot under General Diseases.
6. *Root Rot* — See (34) Root Rot under General Diseases. May be associated with nematodes (e.g., root-knot, root-lesion or meadow).
7. *Chlorosis* — Common in alkaline soils. See under Maple.

SPRENGER ASPARAGUS — See Asparagus
SPRING GLORY — See Forsythia
SPRUCE — See Pine
SPURGE — See Poinsettia
SPURGE LAUREL — See Daphne
SQUASH — See Cucumber
SQUILL — See Tulip
SQUIREL CORN — See Bleedingheart
STACHYS — See Salvia
STAGGERBUSH — See Blueberry
STANHOPEA — See Orchids
STANLEYA — See Cabbage
STAPHYLEA — See American Bladdernut
STARFIRE — See African - violet
STARGLORY — See Morning - glory
STAR - OF - BETHLEHEM — See Tulip
STARRY CAMPION — See Carnation
STATICE — See Sea - lavender
STENANTHIUM — See Tulip
STENOLOBIUM — See Trumpet - tree
STEPHANOMERIA — See Chrysanthemum
STERNBERGIA — See Daffodil
STEVIA — See Chrysanthemum
STILLINGIA — See Castorbean
STOCK — See Cabbage
STOKES - ASTER (Stokesia) — See Chrysanthemum
STONECRESS — See Cabbage
STONECROP — See Sedum
STONEMINT — See Salvia
STORKSBILL — See Geranium
STRANVAESIA — See Apple
STRAWBERRY (*Fragaria*)

1. *Black Root Rot Complex* — General and serious. Plants are stunted and sickly. Often wilt, wither, and die about fruiting time. Leaves may become purplish or bronzed with red petioles. Roots are stunted. Dark, reddish-brown to black (inside

and out) and dead. May resemble "rat-tails." Feeding roots are often lacking. Fruit often dries up without ripening. Commonly follows winter injury. May be due to soil fungi, nematodes, fertilizer burn, drought, toxic salts in the soil, or a combination of two or more of these. See Figure 47A under General Diseases. *Control:* Purchase certified, virus-free, heat-treated plants of adapted varieties with white healthy roots. Plant in light, fertile, well-drained soil rich in organic matter. Control leaf and fruit diseases and insects. Follow the strawberry spray program in the Appendix (Table 10). Apply chlordane, dieldrin, or aldrin following the manufacturer's directions. This treatment controls grubs, crown borers, and other soil insects. Thoroughly mix with the top 4 to 6 inches of soil before planting. Control nematodes as given under Root-knot (below). Keep plants vigorous by fertilization and rotate beds every 2 years. Follow local recommendations to prevent winter injury. In many areas, root rot can be checked by a soil treatment:

A. *For New Plantings:* Mix zineb 65 to 75 per cent with sand and apply to the top of loose, fairly dry soil. Use $\frac{1}{2}$ to 1 ounce of zineb per square foot and thoroughly mix into the upper 5 to 6 inches of soil. Or dig a preplanting trench and drench the soil with zineb (2 tablespoons per gallon). Set plants in treated soil.

B. *For Established Plantings:* Dig a V-shaped trench on either side of the row and close to the plants. Drench soil with zineb as outlined above.

2. *Winter Injury* — Plants are stunted. Often gradually die before the fruit is all picked. Roots are black and dead. But wood under the bark at the crown is not discolored as with *Verticillium Wilt*. See also under Black Root Rot (above). *Control:* Apply a mulch in the fall, according to local recommendations. Follow other recommended cultural practices. Check with your county agent or extension horticulturist. Plant recommended, adapted varieties.
3. *Red Stele* — Fairly common throughout the northern $\frac{2}{3}$ of the United States in low, wet areas. In the spring of the first bearing year plants are often stunted with cupped, dull, bluish-green leaves. Later the older leaves turn yellow or red, roll, wilt, and die about fruiting time. The inner core (stele) of the lower parts of the roots is brick-red in the spring and later brownish-red to black. About harvest time the roots turn brown to black, rot, and resemble rat-tails with few lateral roots. Few fruit are produced. *Control:* Rotate. Plant certified, disease-free plants in light, well-drained soil. Avoid low wet spots. Plant normally resistant varieties: Aberdeen, Fairland, Late Giant, Maine-55, Midway, Monmouth, Orland, Pathfinder, Plentiful, Puget Beauty, Redcrop, Redglow, Siletz, Sparkle, Stelemaster, Surecrop, Temple, and Vermilion. Since a number of races of the red stele fungus occur, a variety resistant in one area may be susceptible in another. Soil fumigation with chloropicrin, Vapam, V.P.M. Soil Fumigant, Trizone, and methyl bromide (pages 440-44) has given good results. Follow the manufacturer's directions.
4. *Verticillium Wilt* — Usually occurs in patches. Often confused with other root and crown rots and winter injury. Older leaves wilt, turn reddish-yellow or dark brown and often die about fruiting time. Young leaves wilt and tend to curl up along the midvein. Plants are often stunted, dry, and flattened with small, yellowish leaves. Brownish streaks occur inside crown and roots. Highly *susceptible* varieties: Armore, Dixieland, Earlidawn, Jerseybelle, Pocahontas, and Sparkle. *Control:* Same as for Red Stele (above). Three- to 6-year rotation excluding tomato, pepper, potato, eggplant, okra, bramble fruits, and strawberry. Somewhat *resistant* varieties: Aberdeen, Catskill, Cavalier, Gem, Grenadier, Howard 17 (Premier), Marshall, Robinson, Sierra, Siletz, Surecrop, Tennessee Beauty, and Vermilion. Soil fumigation using chloropicrin (Table 14 in the Appendix) has given excellent control as has a mixture of chloropicrin and methyl bromide.

5. *Leaf Spots, Leaf Scorch, Black-Seed* — General. Favored by cool, wet weather. Small, dark purple or reddish-purple spots on the leaves which may later develop whitish centers. Leaves may have a dried, scorched look. "Black-seed" on the fruit. Similar spots or streaks may develop on the petioles, stolons, and fruit stalks. Caps of berries may turn brown. Both berry yield and quality is reduced. Runner plants are weakened. See Figure 15D under General Diseases. *Susceptible* varieties: Armore, Fairland, Jerseybelle, Pocahontas, Redglow, and Sparkle. *Control:* Avoid matted, crowded beds and spring applications of a fertilizer high in nitrogen to bearing beds. Keep down weeds. Rotate beds every 2 years. Plant in well-drained soil. Before planting, remove the older leaves and then soak plants for 15 minutes in a zineb solution (1 ounce of zineb 65 to 75 per cent in 3 gallons of water). Apply captan, thiram (Thylate), or ferbam at 10-day intervals, starting when the first leaves are unfolding and continue until berries are half size. See the spray program in the Appendix (Table 10). Use captan when berries start to color and during the harvest season. Normally *resistant* varieties to Leaf Spot, Scorch, or both: Albritton, Aroma, Blakemore, British Sovereign, Catskill, Crimson Flesh, Cyclone, Dorsett, Dunlap, Earlimore, Empire, Fairfax, Howard 17 (Premier), Klonmore, Massey, Mastadon, Midland, Missionary, Ogallala, Robinson, Rockhill, Siletz, Southland, Stelemaster, Surecrop, Tennessee Shipper, and Vermilion. Check with your county agent or extension horticulturist to see if these varieties are adapted to your area.
6. *Leaf Blight* — Large, round to irregular, reddish purple to dark brown spots or V-shaped blotches on the leaves with purplish margins. Similar spots occur on the sepals or cap of the fruit. Older leaves are blighted and later die in large numbers. Runner plants are weak. Yield is reduced. *Control:* Same as for Leaf Spots (above). Apply phenyl mercury in the fall before mulch is applied or in early spring before the first leaves emerge. Somewhat *resistant* varieties: Earlidawn, Empire, and Howard 17 (Premier).
7. *Fruit Rots* — Cosmopolitan. Severe in wet seasons. Small, tan, or water-soaked to dark brown or black and spongy or leathery, enlarging spots on ripening fruit. Rotted areas may be covered with a white, blue-green, tan, gray, or black mold. Fruit resting on soil or in dense plants are more commonly attacked. Flowers may be blasted and set no fruit. *Control:* Same as for Leaf Spots (above). Pick fruit early in the day. Handle carefully. Dip baskets of fruit in a captan 50 solution (2 tablespoons per gallon), dry rapidly, and refrigerate promptly. Do not apply thiram or captan to fruit grown for canning or quick-freezing. If practical, mulch to keep fruit off the soil. Apply captan at 3- to 5-day intervals through the picking season. See the spray program in the Appendix (Table 10).
8. *Powdery Mildew* — General in the northern half of the United States in cool weather. Leaflets curl, roll upward, and are scorched at the margins. Leaflets may be dull gray or purplish-red. Later wither and die. Buds, flowers, fruit stems, and underleaf surface are covered with a thin, whitish-gray mold. Highly *susceptible* varieties: Armore, Redglow, Robinson, and Tennessee Beauty. *Control:* Avoid planting in shaded areas or where air circulation is poor. *Resistant* varieties: Aberdeen, Dorsett, Dunlap, Empire, Erie, Essex, Klondike, Marshall, Orland, Puget Beauty, Red Coat, Sierra, Siletz, Sioux, Sparkle, Sparta Everbearing, and Tahoe. If serious enough, apply Karathane or sulfur plus wetting agent, two or three times, 10 days apart, starting when mildew is first seen. Don't apply if the weather is hot. Do not apply sulfur to berries to be canned or put in metal containers.
9. *Crown Rots, Southern Blight* — Leaf petioles and fruit stems wilt and rot at the crown. Rot may move upward causing stems to collapse. A gray or white mold may grow on affected parts in damp weather. *Control:* Same as for Leaf Spots and

Black Root Rot (both above). Drench affected areas with Terraclor 75 per cent following the manufacturer's directions.

10. *Virus Complex* (crinkles, mottle, curly-dwarf, mosaic, multiplier, leaf curl, leaf roll, stunt, veinbanding, yellows, green petal or aster yellows, witches'-broom, yellow-edge) — General. Symptoms variable depending on the viruses and varieties involved, temperature, nutrition, and other factors. Many varieties may be virus-infected, yet show no symptoms. Leaves may be spotted or edged with yellow, crinkled, puckered, twisted, and cupped (or rolled) upward or downward. Leaves are often dwarfed or mottled light green or yellow. Plants may be stunted, bushy, or dwarfed (Stunt and Witches'-broom), spindly, low in vigor, malformed, and yellow. Stolons may be flattened, thickened, and distorted. Plants infected with Aster Yellows develop green flower petals with apparent developing berries producing elongate to leaflike seeds. Fruit yield and runner production are reduced. *Control:* Plant only certified, virus-free plants from a reputable nursery. Malathion sprays control aphids and leafhoppers which transmit the viruses. Follow the spray program in Table 10 of the Appendix. Destroy wild and virus-infected strawberries before setting out new plants. Destroy abnormal plants when seen during the first season. Locate new beds as far from old bearing beds as possible.
11. *Leaf Variegation, Spring or Blakemore Yellows* — General. An hereditary character found in certain varieties. Symptoms variable. In cool springs (temperature below 50° F.), yellow mottling, spotting, or streaking of leaves of Blakemore, Climax, Empire, Howard 17 (Premier), Vermilion and most everbearing varieties occurs. Leaves gradually show less green color becoming a golden yellow. Plants never recover. *Control:* Grow "yellows-resistant" strains of susceptible varieties which are certified, virus-free. Destroy infected plants when found. Do not use runners from variegated mother plants.
12. *Rhizoctonia Bud Rot* — Widespread in low areas during cool, wet spring weather. Flower and leaf buds turn brown and die. Outer leaves lie flat on the ground and become darker green than normal. Plants die or produce weak, spindly growth and no fruit. Stolons or runners from affected plants may be girdled and brown at the base. *Control:* Same as for Black Root Rot and Leaf Spots (both above). Do not set plants deep or cover crowns during cultivation.
13. *Slime Molds* — White, bluish-gray, or yellow slimy masses up to an inch or more in diameter grow on plants during and following damp weather. Masses usually become powdery. More unsightly than harmful. See Figure 166. *Control:* None necessary. Quickly disappears in dry weather.
14. *Root-knot* — Plants may be stunted, sickly, even die. Small to large, round to irregular, knotlike galls form on the roots. *Control:* Plant certified, heat-treated plants in clean soil. Nurserymen soak dormant plants in hot water (124° F.) for 7½ minutes, (127° F.) for 3 minutes, or (130° F.) for 1 minute. Keep down weeds. Keep plants vigorous by maintaining high soil fertility and watering during dry periods. Rotate. Cultivate very shallowly. If severe, fumigate soil in early fall before planting. Use D-D, EDB, chloropicrin, Telone, Nemagon, or Fumazone (pages 440-44). Follow the manufacturer's directions.
15. *Other Root-feeding Nematodes* (dagger, lance, pin, ring, root-lesion, sheath, spear, spiral, sting, stubby-root, stylet or stunt, tetylenchus) — Plants often decline, are stunted, lack vigor, are less productive, and more easily damaged by drought or winter injury. Small roots may become dark brown to black and often die back. The root surface often shows dark spots or is entirely brown to black. Some plants may die. Often associated with the Black Root Rot Complex (above). *Control:* Same as for Root-knot (above).



Fig. 166. Slime mold on strawberry.

16. *Spring and Summer Dwarf or "Crimp," Leaf and Bud Nematodes* — Center leaves are twisted, cupped, and distorted. May be crimped, greatly dwarfed, narrow, glossy, stiff, and darker green than normal. Growth is stunted. Plants are weakened or killed and fruit yield is reduced. The causal nematodes live in the leaf buds or crown of plants. See Figure 36B under General Diseases. *Control:* Dig up and burn infested plants when first noticed. Plant only certified, heat-treated plants. See Root-knot (above). Set these in fumigated soil. Three- to 4-year rotation. Nemagon and Fumazone may be used around plants in the field. Follow the manufacturer's directions.
17. *Bulb and Stem Nematode* — Mostly in the Pacific Northwest following clover. Plants are stunted, twisted, and puckered. Often appear ragged or unthrifty. Runners, stems, petioles, and fruit stalks are shortened and swollen. *Control:* Same as for Dwarf (above).
18. *Chlorosis* — Commonly an iron deficiency in alkaline soils. The normal leaf color gradually fades. When severe, plants become a creamy yellow. *Control:* Check with your extension horticulturist or plant pathologist. Spray with ferrous sulfate or ferbam to maintain normal green color.
19. *Cauliflower Disease* — Numerous, dwarfed shoots at the crown. Resembles a cauliflower. Often associated with nematodes. See (28) Leafy Gall under General Diseases. *Control:* Dig up and destroy infected plants. Otherwise same as for Root-knot (above).
20. *Anthracnose* — Florida. Runners and rhizomes or leaf petioles are spotted, girdled, and killed by enlarging, light brown to black, sunken cankers. Runners later turn brown to black. *Control:* Follow the strawberry spray program in Table 10. In

addition, apply bordeaux mixture at 10- to 14-day intervals during warm, moist weather starting in July.

21. *Downy Mildew* — See (6) Downy Mildew under General Diseases.

22. *Fire Blight* — See under Apple.

For additional information on strawberry diseases, read U. S. Department of Agriculture Farmers' Bulletin No. 2140, *Strawberry Diseases*.

STRAWBERRY - BUSH — See Bittersweet

STRAWBERRY - TREE — See Blueberry

STRAWFLOWER — See Chrysanthemum

STRELITZIA — See Bird - of - Paradise Flower

STREPTANTHERA — See Iris

STRIPED SQUILL — See Tulip

STYRAX — See Silverbell

SUGARBERRY — See Hackberry

SULTAN — See Balsam

SUMAC [CHINESE, CUTLEAF, EVERGREEN, FLAME - LEAF or SHINING, FRAGRANT, JAVA, LAUREL, SMOOTH, STAGHORN, SUGAR], PURPLE SMOKEBUSH (*Rhus*); SMOKE TREE [AMERICAN, COMMON, PURPLE] (*Cotinus*); PISTACHE, PISTACHIO (*Pistacia*); PEPPERTREE [BRAZIL, CALIFORNIA] (*Schinus*)

1. *Wilts* (*Fusarium* and *Verticillium*) — Widespread. Leaves wither, wilt, and hang down. May cling to the stem. Brown or reddish-brown streaks in the wood just under the bark. Branches may wilt suddenly or gradually with dwarfing and yellowing of the leaves, then take on premature fall color. *Control:* Destroy severely infected plants. Prune out wilting branches. Fertilize and water to increase vigor. Avoid wounding the roots or trunk near the ground line. When disease is first evident, try working zineb (1 pound to 20 square feet) into the soil around the plant and then drench with water.
2. *Powdery Mildew* — Widespread on sumac. White, powdery mold coating on the leaves from midsummer on. Leaves may wither. *Control:* When disease appears, spray several times at weekly intervals. Use sulfur, Karathane, or Acti-dione.
3. *Leaf Spots* — General. Spots of various colors, shapes, and sizes on the leaves. *Control:* If serious enough, spray at 10- to 14-day intervals, during wet periods. Use zineb or maneb.
4. *Wood and Heart Rots* — General. See under Birch, and (23) Wood Rot under General Diseases.
5. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases. May be associated with nematodes (e.g., burrowing, stem, stylet or stunt).
6. *Stem Cankers, Dieback, "Umbrella Disease"* — See under Apple and Elm.
7. *Leaf Curl or Blister* (sumac) — See under Birch, Peach, and (10) Leaf Curl under General Diseases.
8. *Rusts* (smoketree, sumac) — Minor problem. See (8) Rust under General Diseases. Alternate hosts include wild grasses.
9. *Root-knot* — See (37) Root-knot under General Diseases.

10. *Thread Blight* — Southern states. See under Walnut.
11. *Mistletoe* — See (39) Mistletoe under General Diseases.

SUMMER - CYPRESS — See **Beet**

SUMMER - HYACINTH — See **Tulip**

SUMMER - LILAC — See **Butterflybush**

SUNDROPS — See **Evening - primrose**

SUNFLOWER — See **Chrysanthemum**

SUNROSE or FROSTWEED (*Helianthemum*); FROSTWORT (*Crocanthemum*)

1. *Leaf Spots* — Small, more or less round, white or gray spots on the leaves with dark margins. Centers of spots may be sprinkled with black specks. *Control:* Spray several times, 10 to 14 days apart, using zineb, maneb, or fixed copper.
2. *Root Rot* — See (34) Root Rot under General Diseases.

SWAMPBAY — See **Avocado**

SWAMP - PRIVET — See **Ash**

SWAN RIVER DAISY — See **Chrysanthemum**

SWEET ALYSSUM — See **Cabbage**

SWEET BASIL — See **Salvia**

SWEETBAY — See **Magnolia**

SWEETBELLS — See **Labrador - tea**

SWEET CORN — See **Corn**

SWEETFERN (*Comptonia*)

1. *Rust, Blister Rust* — Long, thin, brown, threadlike "spore horns" extend out from the underleaf surface. Or curled, "ram's-horn" leaves with numerous yellow-orange cluster cups. Alternate hosts include 2- and 3-needle pines (where stem galls are formed) or southern white-cedar. These two rusts are rare except near their alternate hosts. *Control:* Do not plant Sweetfern near pitch or hard pines or southern white-cedar.

SWEETGALE — See **Waxmyrtle**

SWEETGUM — See **Witch - hazel**

SWEET - JARVIL — See **Celery**

SWEET MARJORAM — See **Salvia**

SWEETOLIVE — See **Osmanthus**

SWEETPEA — See **Pea**

**SWEET - PEPPERMUSH or PEPPERBUSH [JAPANESE, PINK],
WHITE - ALDER (*Clethra*)**

1. *Root Rot* — See under Apple, and (34) Root Rot under General Diseases.
2. *Leaf Spot* — See under Maple.

SWEETPOTATO (*Ipomoea*)

1. *Black Rot* — General and serious. Sickly yellow foliage. Roundish, small to large, black, sunken spots on the underground stems and sweetpotato roots. Potato has a bitter quinine taste. Often dry and corky. Sprouts may be killed before emergence. See Figure 46C under General Diseases. *Control:* Use certified, disease-free seed potatoes or certified healthy slips (aerial stem cuttings). Plant in clean, well-drained soil. Keep down weeds. Control nematodes and soil insects, sweetpotato weevils, and other pests. Check with your extension entomologist regarding recommended chemicals. Before bedding, dip uncut roots in a warm (60° to 80° F.) 1:1,000 solution of mercuric chloride for 8 to 10 minutes, or an instant dip in Semesan Bel (1 pound in 7½ gallons of water), or Puratized Agricultural Spray (½ pint in 5 gallons). Follow the manufacturer's directions. Discard sprouts that appear sickly or show black spots. Resistant varieties: Oklahoma 24 or Allgold, and Sunnyside. Clean up all debris and spray storage area with copper sulfate (1 pound in 10 gallons of water) or formaldehyde (1:50 solution). Or fumigate air-tight storage houses with chloropicrin (½ pound per 1,000 cubic feet) for 24 hours. Use a minimum temperature of 70° F. Store only sound, blemish-free sweetpotatoes after curing for 10 to 14 days at 80° to 90° F. and a relative humidity of 90 per cent. Store in clean baskets at 55° to 60° F. and a humidity of 85 to 90 per cent. Dip disease-free roots and base of sprouts before planting, in a zineb, thiram, or ziram solution (1½ ounces per gallon). Three- or 4-year rotation.
2. *Storage Rots* — General and serious. Mushy and watery, spongy, or firm and hard, yellowish, brown, pink, dark red, grayish-brown, purplish, or black rot. Potatoes shrink, may become hard and dry (mummified). Rotted areas may be covered with a white, gray, blue, green, or black mold. Potatoes may rot completely in just a few days. See Figure 167. *Control:* Same as for Black Rot (above). Harvest during warm, dry weather before frost kills the vines. Handle carefully while digging, curing, and storing. Do not let potatoes lie in the hot sun for over an hour. Control diseases in the field.
3. *Fusarium Wilt or Stem Rot* — General, often serious. Leaves turn yellow or brownish, wilt, and drop. Plants are stunted, upright, and bushy. Vines later wilt and

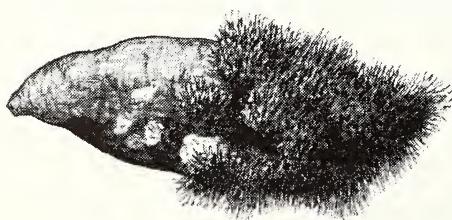


Fig. 167. Soft rot of sweetpotato showing the moldy growth or "whiskers" of *Rhizopus*.

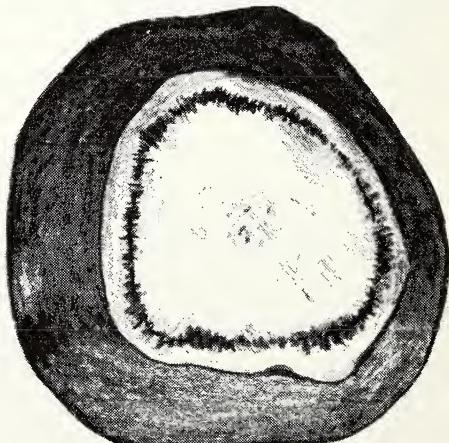


Fig. 168. Fusarium wilt or stem rot of sweetpotato. Cross section through a potato, showing the dark ring caused by *Fusarium*.

collapse. Brown to black streaks occur inside the stems, while there is a brown to blackened ring in the sweetpotato flesh. See Figure 168. Very susceptible varieties: Big-Stem Jersey, Georgia, Little-Stem Jersey, Maryland Golden, Nancy Hall, Porto Rico, Red Jersey, and Yellow Jersey. *Control:* Same as for Black Rot (above). Plant resistant varieties where adapted: Allgold, Coppergold, Dahomey, Dooley, Goldrush, Key West, Nugget, Pumpkin, Red Brazil, Triumph, White Yam, and Yellow Strassburg.

4. *Foot Rot or Die Off* — Widespread. Brown areas on the stem at or near the soil line. Stem is girdled causing parts beyond to turn yellow, wilt, and die starting in midsummer. A firm brown rot of the sweetpotato, usually at the stem end. Yield is reduced. *Control:* Same as for Black Rot (above).
5. *Leaf Spots, Leaf Blights* — Widespread. Round to angular, white, gray, or brown leaf spots. Often with a definite margin. Centers of spots may later be sprinkled with black specks or mold growth. *Control:* Same as for Black Rot (above). If serious enough, apply zineb or maneb several times, 10 days apart.
6. *Root-knot* — Widespread. Plants stunted, sickly, and yellowish. Potatoes may be pitted or cracked and yellowish. Nancy Hall types are very susceptible. *Control:* Resistant varieties, where adapted: Heartogold, most Jersey varieties, Nemagold, and South Carolina E7. Porto Rico varieties are intermediate in resistance. Fumigate the soil with D-D or EDB (pages 440-44). Seed roots may be disinfested by dry heat (exactly 113° F.) for 30 hours or by soaking in hot water (116° F.) for 65 minutes. Do not overheat.
7. *Scurf or Soil Stain* — General. Small, round, rusty-brown to almost black spots and blotches on the potato surface. Spots may sometimes run together forming a patch over the potato. Skin may crack. Potatoes in storage may lose some water, shrink, become spongy, then dry and hard. *Control:* Same as for Black Rot (above). Or dip roots prior to planting in a thiram, ferbam, ziram, or captan solution (2 pounds in 5 gallons of water). Avoid planting in heavy, wet soils high in organic matter. Practice a 5- or 6-year rotation. Varieties differ in resistance.
8. *Soil Rot or Pox* — General in localized areas. Worst in dry soils in dry seasons. Plants may be dwarfed and sickly with small, thin, pale green to yellow leaves. Potatoes are often deformed and dumbbell-shaped with rough, scabby pits or corky surface areas that dry up and fall out. Dark girdling spots develop on the roots and underground stem. Yield and quality of potatoes may be greatly reduced. Roots decay. Disease does not normally develop in soils below pH 5.2. Rot organisms later attack affected potatoes. *Control:* Plant disease-free stock in uninfested soil or fumigate soil with chloropicrin or chloropicrin plus methyl bromide (pages 440-44). Four- to 6-year rotation. Plow under green manure crop before planting. Irrigate thoroughly as edible potatoes begin to form. Where practical, acidify infested soil (to pH 5.0) by adding sulfur, based on a soil test. The varieties Centennial, Heartogold, and Acadian have some resistance. More resistant varieties should be available in the future.
9. *White-rust* — General but not serious. Irregular yellow areas form on the leaves which later turn brown. Spots on the underside of leaves turn pale green then brown and are covered with white, powdery pustules. Leaves and shoots may be somewhat malformed. Swellings occur on the stems and petioles. *Control:* Keep down weeds. Plant where air circulation is good. Spraying as for Leaf Spots (above) may be beneficial. Varieties differ in resistance.
10. *Internal Cork, Leaf Spot* — Widespread in southern states. Irregular, dark brown to black, hard, corky "islands" in the sweetpotato flesh. Roots appear normal outside. Foliage symptoms are variable. See Figure 169. Internal cork is part of the

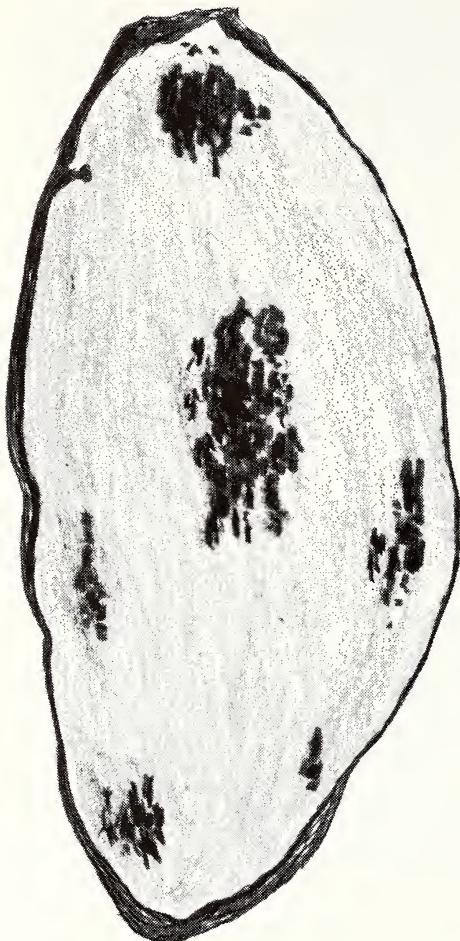


Fig. 169. Internal cork of sweetpotato. Lengthwise section through a potato showing the dark corky "islands" in the flesh.

Feathery Mottle virus complex. Whitish spots which become reddish to purplish and finally dead, develop on the leaves. Leaves may be slightly mottled. Porto Rico and Goldrush are generally susceptible. Some varieties are symptomless carriers. **Control:** Plant virus-free seed roots as far away from infected plantings as possible. The distance should be at least 100 yards. Plant less-susceptible varieties, where adapted: Allgold, Earlyport, Golden Skin, Jersey Orange, Maryland Golden Sweet, Nancy Gold, Nancy Hall, Nemagold, Nugget, Oklahoma 2, Pelican Processor, Ranger, Red Gold, Red Nancy Hall, and Yellow Jersey. More resistant varieties should be available in the future. Control aphids which transmit the viruses, using malathion or nicotine sulfate. Cure and store as for Black Rot (above), except for seed stocks which should be kept at 70° F. to better detect the virus.

11. **Mottle-leaf or Mosaic, Yellow Dwarf, Feathery Mottle** — Southern states. A virus complex causing variable symptoms. Foliage may or may not be mottled. Leaf shape is abnormal. Younger leaves may show a feathery yellowing along the smallest veins or small, diffuse, yellow spots or streaks. Small to large, pale green areas later develop. The remainder of the leaf is very dark green. Plants are later stunted. May

- appear rosette-like. Yield is reduced. Nancy Hall and Porto Rico are very susceptible. *Control:* Same as for Internal Cork (above). Destroy the first infected plants. Control aphids and whiteflies which transmit the viruses. Use malathion.
12. *Mottle Necrosis, Leak* — Widespread. Irregular, brownish, somewhat sunken spots on the sweetpotato. When roots are cut across, scattered, irregular, chocolate-brown dead areas are seen, giving a marbled appearance. *Control:* Four-year rotation. Avoid planting very susceptible varieties, e.g., Big-Stem Jersey, Georgia, Triumph, and Yellow Jersey.
13. *Gray-mold Blight, Bud Rot* — Cosmopolitan on sprouts. Bedded potatoes may rot. Newly emerged sprouts are killed. *Control:* Use disease-free seed potatoes and slips. Practice good bed management. Avoid overheating and overwatering.
14. *Root Rots* — Feeder roots decay. Sweetpotato may be completely rotted. Plants stunted and sickly. Often associated with nematodes (e.g., awl, burrowing, dagger, lance, pin, reniform, ring, root-lesion, rot, spiral, sting, stubby-root, stylet or stunt). *Control:* Same as for Black Rot and Root-knot (both above). Plant in well-drained soil. Varieties differ somewhat in resistance.
15. *Rust* — Mostly in southern states. Colorless to deep orange-red, dusty pustules on the underside of the leaves. If severe, leaves may wither and die. Pines are the alternate host. *Control:* Not usually necessary. Try spraying as for Leaf Spots (above).
16. *Bacterial Wilt* — Mostly southern states. See (15C) Bacterial Wilt under General Diseases.
17. *Curly-top* — Western states. See (19) Curly-top under General Diseases.
18. *2,4-D Injury* — See under Grape. Sweetpotato is very susceptible.
19. *Thread Blight* — Southeastern states. See under Walnut.
20. *Crown Rot, Southern Blight* — See under Hollyhock.
21. *Internal Brown Spot, Boron Deficiency* — See under Beet.
22. *Verticillium Wilt* — See (15B) Verticillium Wilt under General Diseases.
23. *Slime Molds* — See under Lawngrass.
24. *Sooty Mold* — See (12) Sooty Mold under General Diseases.

SWEET SCABIOUS — See Scabiosa

SWEETSHRUB — See Calycanthus

SWEET SULTAN — See Chrysanthemum

SWEET - WILLIAM — See Carnation

SWISS CHARD — See Beet

SWORD BEAN — See Bean

**SYCAMORE [AMERICAN or BUTTONWOOD, ARIZONA, CALIFORNIA],
PLANETREE [LONDON, ORIENTAL or EUROPEAN] (*Platanus*)**

1. *Anthracnose, Leaf Blight, Twig Canker* — General and damaging on American and Western sycamores and Oriental planetree in wet springs. London plane is rather resistant. Young expanding leaves suddenly or gradually turn brown and die in early spring. Often resembles frost injury. Brown dead areas develop along and between the leaf veins. Leaves often drop early. See Figure 170. Cankers may girdle and kill twigs and smaller branches. Often results in witches'-brooms. *Control:* Collect and burn fallen leaves and twigs. Remove dead and severely cankered

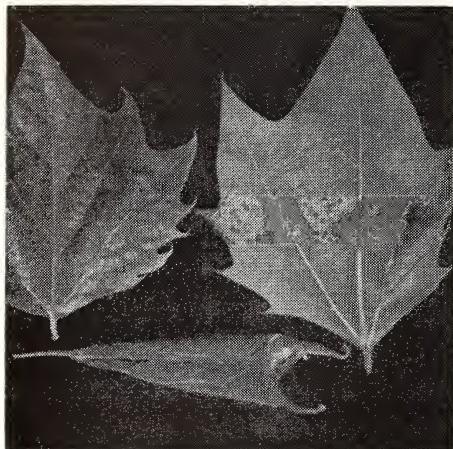


Fig. 170. Sycamore anthracnose.

twigs and limbs. Thin out the crown for better air circulation. Fertilize severely infected trees to increase vigor. Apply phenyl mercury, dodine (Cyprex), fixed copper, zineb, dichlone, manebe, or captan one to three times, 7 to 10 days apart, starting as the buds begin to swell.

2. *London Plane Blight, Cankerstain* — Serious in eastern states. Much less common on American sycamore. Foliage becomes thin. Leaves are dwarfed. Leaves later wither, turn yellow, and drop in large numbers in early summer. Trees die within a year or two. Elongated, rough, sunken cankers develop on the trunk and larger branches. The girdling cankers kill the parts beyond. The wood underneath cankers shows reddish-brown to bluish-black streaks or wedge-shaped sections when cut through. The causal fungus enters through bark injuries of all kinds. *Control:* Remove and burn infected trees as soon as possible. Avoid injuring the bark. Pruning tools and ladder parts which touch the wood should be thoroughly washed in 70 per cent denatured alcohol or household bleach between trees. Apply a tree wound dressing containing a fungicide (e.g., gilsonite-varnish type paint containing 0.25 per cent phenylmercury nitrate, 6 per cent phenols, or 0.5 per cent dichlone, ferbam, phaltan, or thiram. Examples: Gilbert's Tree Wound Dressing and Flo-zon Tree Wound Paint). Whenever possible, prune trees in the wintertime.
3. *Leaf Scorch* — Browning or scorching of the leaves between the veins or along the margins following hot, dry, windy weather in July and August. *Control:* Water during summer droughts. Prune and fertilize trees to increase vigor.
4. *Wood Rot, Trunk Rot, Heart Rot* — See under Birch, and (23) Wood Rot under General Diseases. Keep trees growing vigorously.
5. *Powdery Mildews* — Widespread. Powdery, grayish-white mold on the leaves and young shoots. Leaves turn yellow, wither, and fall early. If severe, leaves may be stunted and malformed. *Control:* When practical, apply two sprays of sulfur or Karathane, 10 days apart.
6. *Leaf Spots* — Small, brown, gray or black spots on the leaves. *Control:* Same as for Anthracnose (above).
7. *Crown Gall* — Rough, irregular, swollen galls form at the base of the trunk or on the roots. Trees lack vigor. Make poor growth. Young trees may die. *Control:* See under Apple.
8. *Winter Injury* — See under Elm.

9. *Root Rots* — Trees gradually decline in vigor. Foliage is thin and sickly. Leaves may turn yellow, wither, and drop early. *Control:* See under Apple.
10. *Cankers, Dieback, Twig Blight* — Twigs and branches are discolored, wilt, and die back from cankers on the twigs and limbs. If severe, trees may die prematurely. *Control:* Avoid bark injuries. Maintain good tree vigor by fertilizing and watering during dry periods. Cut off and burn cankered parts. Make cuts well below any sign of infection. Destroy severely infected trees. Control insects with malathion sprays.
11. *Rosy Canker of London Planetree* — Long, narrow cankers (inner bark pink to red-colored) develop on trunks when roots are injured by manufactured illuminating gas. If severe, foliage may suddenly wilt and turn brown. Branches die back. *Control:* Call the gas company and have the leak repaired. Follow the suggestions outlined by the gas company officials.
12. *Wetwood, Slime Flux* — See under Elm.
13. *Sooty Blotch* — See under Apple, and (12) Sooty Mold under General Diseases.
14. *Chlorosis* — Common in alkaline soils. See under Maple and Walnut.
15. *Mistletoe* — See (39) Mistletoe under General Diseases.

SYMPHORICARPOS — See **Snowberry**

SYNGONIUM — See **Calla**

SYNTHYRIS — See **Snapdragon**

SYRINGA — See **Lilac**

TABEBUIA — See **Trumpettree**

TABERNAEMONTANA — See **Oleander**

TAENIDIA — See **Angelica**

TAGETES — See **Chrysanthemum**

TALLOWTREE — See **Castorbean**

TAMARACK — See **Larch**

TAMARISK [COMMON, FIVE - STAMEN, FRENCH, ODESSA] (Tamarix)

1. *Twig Blight, Canker* — Twigs and branches die back from discolored cankers. Foliage beyond withers and dies. *Control:* Prune out and burn dead and cankered wood. Keep trees growing vigorously by fertilizing and watering during droughts.
2. *Wood Rot* — See under Birch.
3. *Powdery Mildew* — See under Birch.
4. *Root Rot* — See under Apple.

TANBARK - OAK — See **Oak**

TANSY (Tanacetum), TASSELFLOWER — See **Chrysanthemum**

TASSELTREE — See **Dogwood**

TAXODIUM — See **Pine**

TAXUS — See **Yew**

TEABERRY — See **Heath**

TEASEL [COMMON, FULLERS] (*Dipsacus*)

1. *Leaf Spot* — Indefinite, often moldy spots on the leaves. *Control:* Pick off and burn spotted leaves. Burn tops in the fall. If serious enough, spray several times, 10 days apart. Use zineb or maneb.
2. *Stem Rot, Crown Rot, Southern Blight* — Stems rot at the soil line. May be covered with a cottony mold growth. See under *Delphinium*.
3. *Mosaics* — Distinct, light and dark green mottling of the leaves. Leaves may be somewhat malformed. Plants often partly stunted. May die early. *Control:* Keep down weeds. Destroy infected plants when first seen. Control aphids, which transmit the viruses, using malathion or lindane.
4. *Powdery Mildew* — Grayish-white blotches on the foliage. *Control:* Pick off and burn infected leaves. If practical, spray twice, 10 days apart, using sulfur or Karathane.
5. *Downy Mildew* — See (6) Downy Mildew under General Diseases.
6. *Leaf and Stem Nematode* — Flower heads are dwarfed and distorted. See (20) Leaf Nematode under General Diseases. Plant disease-free seed.
7. *Root Rot* — See (34) Root Rot under General Diseases.

TECOMARIA — See **Trumpettree**

TETRAGONIA — See **Beet**

TEUCRIUM — See **Salvia**

TEXAS - BLUEBELL — See **Gentian**

TEXAS SILVER LEAF (*Leucophyllum*)

1. *Twig Canker* — Twigs die back from girdling cankers. See (22) Twig Blight under General Diseases.
2. *Root Rot* — See under Apple, and (34) Root Rot under General Diseases.

THALICTRUM — See **Delphinium**

THERMOPSIS — See **Pea**

THIMBLEBERRY — See **Raspberry**

THISTLE — See **Chrysanthemum and Lettuce**

THRIFT — See **Sea - lavender**

THUJA, THUJOPSIS — See **Juniper**

THUNBERGIA — See **Clockvine**

THYME (*Thymus*) — See **Salvia**

TIARELLA — See **Hydrangea**

TICKSEED, TIDYTIPS — See **Chrysanthemum**

TIGERFLOWER (*Tigridia*) — See **Gladiolus**

TILIA — See **Linden**

TITHONIA — See **Chrysanthemum**

TOADFLAX — See Snapdragon**TOBACCO — See Tomato****TOLMIEA — See Piggy - back Plant**

TOMATO [CHERRY, COMMON, CLIMBING, CURRANT, GRAPE, MAYAN HUSK, PEAR] (*Lycopersicon*); BROWALLIA; PEPPER [CAYENNE, CHILLI, LONG, RED, SWEET or BELL] (*Capsicum*); TREE - TOMATO (*Cyphomandra*); DATURA [HINDU, ANGELS - TRUMPET] (*Datura*); APPLE - OF - PERU (*Nicandra*); TOBACCO, FLOWERING TOBACCO (*Nicotiana*); WHITECUP (*Nierembergia*); PETUNIA [DWARF, GARDEN, SEASIDE, VIOLET, WHITE] (*Petunia*); GROUNDCHERRY, HUSK - TOMATO, CHINESE LANTERNPLANT or WINTERCHERRY, TOMATILLO, CAPE - GOOSEBERRY (*Physalis*); PURPLE - FLOWERED GROUNDCHERRY (*Quincola*); PAINTED - TONGUE (*Salpiglossis*); BUTTERFLY - FLOWER, POORMANS - ORCHID (*Schizanthus*); EGGPLANT, SCARLET or TOMATO EGGPLANT, NIGHTSHADE, JERUSALEM - CHERRY or CHRISTMAS CHERRY (*Solanum*)

1. *Tomato Septoria Leaf Spot or Blight* — General over most of the United States in warm (60° to 80° F.) moist weather. Numerous, small, more or less round, whitish spots with dark margins on the leaves. Spots are later sprinkled with black dots. Leaves may turn yellow and drop in large numbers starting at the base of the plant. Spots also occur on the petioles, stems, blossoms, and fruit stems. Fruit size and quality are reduced. Exposed fruit may sunscald. See Figure 15B under General Diseases. *Control:* Plow under or burn plant debris after harvest. Three- to 5-year rotation excluding potato, pepper, eggplant, and tomato. Plant in well-drained soil where air circulation is good. Seedbed soil should be clean or sterilized (pages 437-44). Treat seed as for Bacterial Spot (below) or plant disease-free, certified plants. Spray plants in the seedbed as for Seed Rot (below). Space plants widely or stake. Keep down weeds in and around (within 50 feet) the garden area. Indoors, increase air circulation; keep the night temperature up (60° to 65° F. or higher than outdoors). Keep plants growing vigorously by fertilizing and watering during dry periods. Grow only *tomato* varieties recommended for your area. Check with your county agent or extension horticulturist. Apply maneb, zineb, or fixed copper every 7 to 10 days, starting when the first fruits are the size of a pea or a walnut. Thorough coverage is essential.
2. *Early Blight, Collar Rot, Alternaria Fruit Rot* (*datura*, *eggplant*, *Jerusalem-cherry*, *pepper*, *petunia*, *tobacco*, *tomato*) — General. Dark brown to black spots on the leaves and lower stem (Collar Rot). Plants may be stunted or even topple over. Most leaf spots are roundish and have concentric rings (target spots). Leaves turn yellow and fall early, starting at the base of the plant, resulting in the sunscalding of fruit. Dark, sunken, leathery spots may develop near the stem end of *tomato* and *pepper* fruit which may be covered with a dark brown mold. Such fruit may drop early. Size and quality of fruit are poor. Spots on the flower stems may cause the blossoms to drop. See Figure 17A under General Diseases. *Control:* Same as for *Septoria Leaf Spot* (above) and *Seed Rot* (below). *Tomato* varieties having some resistance to Early Blight include: Manalucie, Marglobe, New Hampshire Surecrop, Norton, Stone, Texto 2, and W-R Jubilee. *Tomato* varieties resistant to Collar Rot: Southland and Urbana.
3. *Late Blight* (*eggplant*, *Jerusalem-cherry*, *nightshade*, *petunia*, *tomato*) — General and serious in humid regions and in wet seasons. Irregular, greenish-black, water-soaked, rapidly enlarging, greasy spots on the leaves, petioles, and stems. In moist

weather, a whitish-gray downy growth appears, mostly on the underside of the leaves. Infected foliage soon dries, turns brown, and withers. Tomato fruit spots are greasy and dark green to brown or nearly black in color. The fruit are firm with a corrugated appearance. Bacterial Soft Rot often follows. Rotting of the vines is very rapid in moist weather with cool nights (40° to 60° F.) and warm, humid days (70° to 80° F.). Severely affected plants look as if they had been killed by frost. *Control:* Same as for Septoria Leaf Spot (above). If the weather is cool and moist, spray every 5 to 7 days; if warm and dry, every 7 to 10 days. Sprays are much more effective than dusts. *Tomato* varieties which may appear resistant: Garden State, New Hampshire Surecrop, and Southland.

4. *Other Leaf Spots and Blights, Leaf Mold, Anthracnoses* — Widespread in rainy seasons. Small to large, round to irregular spots of various colors, often with borders of a different color. Spots also occur on the leaves, petioles, and stems. Leaves may turn yellow and fall early. Injury is most evident on the lower leaves in moist weather. *Control:* Same as for Septoria Leaf Spot (above). *Tomato* varieties resistant to Gray Leaf Spot, where adapted: Indian River, Manalee, Manalucie, Marion, Rio Grande, Weshaven, and W-R Jubilee. *Tomato* varieties resistant to Leaf Mold (a common indoor problem): Improved Bay State, Improved Vetomold, Manalucie, Leaf-mold Resistant Marglobe, Mold-resistant Waltham Forcing, Tuck-cross O, Tucker's Forcing, Waltham Mold-proof Forcing, and Weibull's Immuna. Indoors, increase ventilation and reduce the humidity as low as practical. Maintain a temperature of 60° to 65° F. Keep the night temperature higher than that outdoors. Keep water off the foliage.
5. *Fruit Spots, Fruit Rots, Anthracnoses* — Cosmopolitan and serious on eggplant, pepper, and tomato. Small to large, circular to irregular fruit spots which are usually sunken, water-soaked, dark yellow (pepper), tan or brown to black, often with concentric zones. Fruit may shrivel and darken or become watery and collapse. Most common on ripening fruit. Fruit may later be covered with a white, pink to red, black, tan, gray, green or yellow to orange mold. Bacterial Soft Rot may follow. Internal rot may be moldy or slimy and pink, gray, or brown to black in color. Some fruit-rotting fungi produce brown or gray spots on the leaves and stems. See Phytophthora Blight, Other Leaf Spots, and Figure 46B under General Diseases. *Control:* Destroy all rotting fruit. Keep *tomato* fruit off the ground by staking or mulching. Handle fruit carefully to avoid cuts and bruises. Keep fruit dry. Plant crack-free *tomato* varieties. Otherwise, same as for Septoria Leaf Spot (above). Spray with manebe, zinebe, captan, ziram, or phaltan. Resistant *eggplant* varieties to Phomopsis Blight: Florida Beauty, and Florida Market. *Pepper* and *tomato* varieties also differ in resistance to certain rots (e.g., *tomato* to Nailhead Spot: Break O'Day, Glovel, Marglobe, Pritchard). Plant in well-drained, disease-free soil, if possible. Control insects using methoxychlor and malathion. Close to harvest use malathion or rotenone. Treat seed as for Bacterial Spot (below). Indoors, same as for Other Leaf Spots (above).
6. *Sunscald* (pepper, tomato) — General in hot, dry weather where blights are uncontrolled. Large, irregular, slightly sunken, whitish areas on fruit with a papery texture. Black, gray, or dark green mold may develop on the affected surface. Entire fruit may later rot. White or reddish spots may develop in the middle of leaves on young plants. See Figure 1A. *Control:* Same as for Septoria Leaf Spot (above). Water and fertilize to keep plants growing vigorously. Avoid varieties with sparse foliage. Handle fruit carefully.
7. *Blossom-end Rot, Leather-end* (pepper, tomato) — General. Slight water-soaked area forms on the bottom $\frac{1}{3}$ the fruit (the blossom-end) which later enlarges, darkens, becomes sunken, flat, leathery, and finally black in color. Spots vary in

size. May affect $\frac{1}{2}$ the fruit. Various fruit rots may follow later. See Figure 1A. *Control:* Plant in well-drained soil. Water during dry periods to maintain an even soil moisture supply and promote steady growth. Mulch plants or cultivate shallowly during dry periods. Fertilize adequately, based on a soil test. Avoid over-fertilizing, especially with nitrogen, and close cultivation. Use sufficient calcium-containing fertilizer, lime, or spray when rot is anticipated (first fruits are the size of golf balls). Some states recommend 4 weekly sprays of calcium nitrate or calcium chloride ($\frac{1}{2}$ to $\frac{3}{4}$ ounce per gallon of water). Before using, check with a local grower, your county agent, or extension horticulturist. Avoid severe pruning. Control leaf spots and blights as given under *Septoria Leaf Spot* (above). Varieties differ in susceptibility.

8. *Tomato Fruit Cracking* — Cracks grow out from the stem of the fruit like a "star"

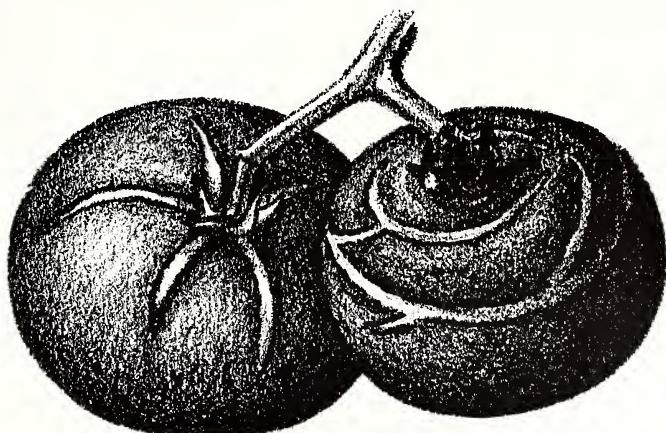


Fig. 171. Tomato fruit cracking.

or cracks occur as rings around the center of fruit. See Figure 171. *Control:* Same as for *Blossom-end Rot* (above). Numerous tolerant varieties are available.

9. *Bacterial Soft Rots* (eggplant, pepper, tomato) — Cosmopolitan. Water-soaked, greasy areas on the fruit which rapidly enlarge. Usually accompanied by a foul odor. In 3 to 10 days the entire fruit is soft, watery, and hangs limply. Follows other diseases, growth cracks, and insect or mechanical injuries. See Figure 172. *Control:* Same as for *Septoria Leaf Spot* and *Fruit Rots* (both above). Handle fruit carefully. Refrigerate promptly after harvest. Control insects with malathion or rotenone sprays applied at least weekly.
10. *Bacterial Spot, Canker, Speck, Wildfire* (primarily eggplant, groundcherry, pepper, and tomato) — General over most of the United States in wet seasons. Small, "scabby," whitish, brown spots or black specks and spots develop on green fruit (Figure 172 and Figure 173). Fruits may be spotted, roughened, cracked, and distorted. Such fruits later rot. Flowers may be blasted and drop off. Plants may be stunted. Small, yellowish-green, brown or black, greasy-appearing leaf spots often with yellowish margins, or small, round, pale green "warts" may form. Spots later may enlarge. Leaves may roll, turn yellow or brown, wilt, and drop off starting at the base of the plant. This often results in sunscald. *Canker* produces elongated, yellowish to yellow-brown stripes or cracks on some *tomato* stems. *Control:* Plant certified, disease-free seed or transplants in disease-free soil. Soak uncertified *tomato*

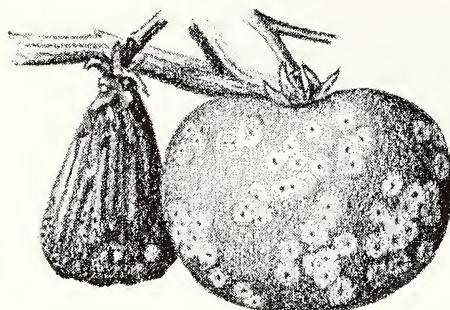


Fig. 172. Bacterial soft rot of tomato (left),
Bacterial canker of tomato (right).

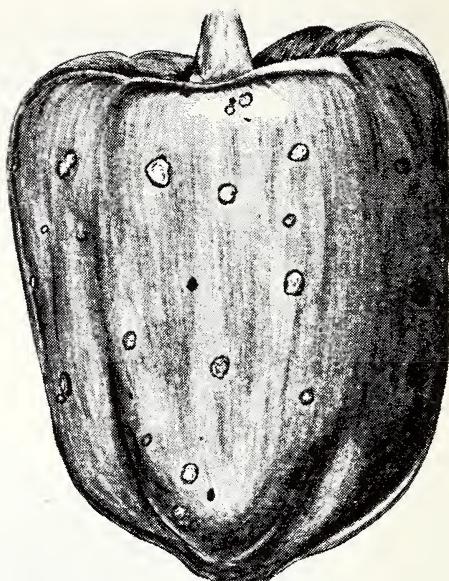


Fig. 173. Bacterial spot of pepper.

and *eggplant* seed in hot water (exactly 122° F. for 25 minutes), dry and dust with thiram or captan before planting. See Table 13 in the Appendix. Soak *pepper* seed for 5 minutes in a 1:1,500 solution of mercuric chloride, rinse for 15 minutes in running water, dry and dust as above. Destroy plant debris after harvest. Four-year rotation. Exclude pepper, tomato, and related weeds in the tomato-potato family. Several seedbed or field sprays of fixed copper (1½ tablespoons per gallon) plus maneb or zinceb (1 tablespoon) or streptomycin (at a concentration of 200 parts per million) should help. Check with your county agent or extension plant pathologist. *Pepper* varieties reported as resistant to Bacterial Spot: Anaheim, Blight-resistant World Beater, Calcom, Harris Earliest, Harris Early Giant, Harris Wonder, Long Red Cayenne, Oshkosh Santanka, Red Chili, Squash, Sunnybrook 833, Sunnybrook Sweet Cheese, Sweet Yellow, Waltham Beauty, Wonder, and Yellow Oshkosh. Maintain high balanced fertility based on a soil test.

11. 2,4-D Injury — General. See under Grape. Fumes may injure plants $\frac{1}{2}$ mile or more away. Tomato and related plants are very sensitive. Leaves and stems are often considerably distorted and twisted. Leaf margins are wavy or frilled. Blossoms drop without setting fruit. Tomato fruit are often cone-shaped or crack open. Contaminated sprayers and pesticide containers are often responsible for injury in the home garden.
12. Mosaics, *Calico*, *Streak*, *Yellow Net* — General, may be serious. Symptoms variable depending on the virus strain, variety, and environmental conditions. Leaves may be mottled with a yellowish-green to light and dark green mosaic pattern. See Figure 174. Affected leaves are usually curled, crinkled, puckered, and deformed. Symptoms may resemble 2,4-D injury with narrow (fernleaf), spindly, shoestring-like leaves. Brown streaks may appear on the stems and petioles. Plants are often stunted, yellowed, and bushy. Fruit are often reduced in size and number. May be malformed with whitish, yellow and green or dead blotches or show rings, mottled patterns or corky brown areas (Internal Browning) under the skin. Blos-soming is reduced. *Petunia* flower petals may be mottled, flecked, streaked, or show ring patterns. May not open completely. Long brown streaks may develop on

tomato and *pepper* stems and fruit, accompanied by a dropping of the leaves, blossoms, and fruit—especially on pepper. Stems may be very brittle. *Eggplant* is often killed. *Control:* Destroy infected plants when first found. Keep down all weeds in and around where plants are growing. Set out disease-free, certified transplants or start with disease-free seed. Wash hands thoroughly with soap and hot water before touching healthy plants. Avoid use of tobacco in any form while working with plants. Losses from certain viruses may be reduced by spraying tomato and pepper plants at transplanting time using 1 gallon of whole or skim milk or 1 pound of dried skim milk mixed with a gallon of water. Apply to 20 square yards of garden or plant bed. Dip hands in whole or skim milk, or 4 ounces of dried skim milk in a quart of water, every 20 minutes whenever handling plants during the season (e.g., plant pulling, transplanting, pruning, tying). Control insects, especially aphids and cucumber beetles which transmit the viruses. Use malathion plus DDT, methoxychlor, or rotenone. *Pepper* varieties resistant to Tobacco Mosaic: Calcom, Caldel, California Wonder, Delaware Belle, Florida Giant, Improved Yolo, Keystone Resistant Giant, Liberty Bell, Merced, Mosaic-Resistant Wonder Giant, Pacific Bell Sweet, Paul's Jersey Giant, Rutgers Worldbeater No. 13, Thick Walled World Beater, Yolo Wonder A or B and Improved B M.R.

13. *Double Virus Streak* (tomato) — Leaves mottled green and yellow. Numerous, small, irregular, grayish-brown to black, papery spots on the top leaves. Stems and petioles develop numerous, long, dark brown or black streaks. The top of the plant may die rapidly or plants become dwarfed, spindly, yellowish, and nonproductive. Fruit may be deformed with small, irregular, greasy-brown blotches. *Control:* Same as for Mosaics (above).
14. *Spotted Wilt, Tip Blight* — Widespread. Symptoms differ greatly with the plant, variety, virus strain, and age of plant. Numerous tiny, brown, yellowish-green,

Fig. 174. Pepper mosaic.



ringlike spots (or bronzing) of the young top leaves and petioles commonly occur. Growing *pepper* and *tomato* tips may show dark streaks, wilt, and wither. Leaves may be mottled yellow and distorted. Plants are often stunted and bushy with drooping leaves. Occasionally die. Small to large pale red, yellowish, white or dark brown to almost black, irregularly mottled blotches (often composed of concentric rings) may develop on *tomato* and *pepper* fruit. Fruit may be roughened and distorted. *Petunia* flowers may show irregular light streaks and blotches. See Figure 33A under General Diseases. *Control:* Same as for Mosaics (above). Control thrips which transmit the virus. Use malathion, DDT, or dieldrin. Check with your county agent, extension entomologist, or a local grower. Tomato varieties differ in resistance.

15. *Ringspot Complex* — Tip leaves are curled and brown. Yellowish-green, dark green, gray or brownish, ring patterns (also line and oakleaf markings) form on the leaves, petioles, and fruits. Plants may be yellowed and stunted, with puckered, mottled, and malformed leaves. *Pepper* and *tomato* fruit are often misshapen. Grasshoppers transmit the viruses. *Control:* Same as for Mosaics (above). Control dagger nematodes (*Xiphinema*) which probably transmit at least one of the viruses (Tomato Ringspot). See under Root-knot (below).
16. *Curly-top, Western Yellow Blight* — Western half of the United States. Plants are stunted and spindling or dwarfed and bushy. Seedlings may turn yellow and die. A pronounced twisting, upward curling, or cupping of the young leaves is common. Foliage becomes stiff, brittle, and droops. Flowers are often malformed. Numerous secondary shoots are often formed. *Pepper* leaf stems curve sharply downward. Plants eventually become yellowed and dwarfed; stiffly erect. Few deformed pepper and tomato fruit are produced after infection occurs. *Tomato* fruits ripen regardless of size. *Control:* Same as for Mosaics (above) and (19) Curly-top under General Diseases. Control leafhoppers which transmit the virus, using malathion or DDT. Resistant *tomato* varieties may be available soon, e.g., Owyhee.
17. *Aster Yellows* (browallia, butterfly-flower, eggplant, painted-tongue, petunia, tomato) — Plants are yellowish, bushy, and dwarfed with many rosette-like, secondary shoots. Flowers are often malformed and greenish. *Tomato* leaves may curl and turn purple or yellow. *Control:* Same as for Curly-top and Mosaics (above).
18. *Eggplant Yellows* — Plants turn yellow starting at the top and progressing downward. Plants are stunted. Yield is greatly reduced. *Control:* Same as for Mosaics (above).
19. *Fusarium Wilts* (browallia, painted-tongue, pepper, petunia, tomato) — Serious in hot, dry weather (80° to 95° F.), especially in central, southern, and western states. Seedlings wilt and die. Older plants are stunted. Leaves wilt, turn yellow, wither, and drop off starting at the base of the plant. Wilting and yellowing or browning may first be only on one side of the plant. Brown streaks occur inside the lower stem and roots. A brown canker may girdle the stem near the soil line. Roots are discolored and rotted. Fruit size and yield are reduced. Injury may be increased by root-feeding nematodes. See Figure 29A under General Diseases. *Control:* Plant disease-free seed or transplants in fertile, well-drained, wilt-free soil. If practical, sterilize or fumigate the soil in seedbeds, cold frames, and greenhouse beds. See below under Root-knot. Practice a 3- or 4-year rotation. Use normally disease-resistant, adapted *tomato* varieties in infested soil: Alamo, Blackhawk, Blair Forcing, Boone, Brookston, Buckeye State, Campbell 146, Chesapeake, Fortune, Garden State, Golden Marglobe, Grothen's Globe WR, Homestead (24, FM, F-M 61), Illinois Pride, Indark, Indian River, Jefferson, Kanora, Kokomo, Kopiah, Manalee, Manalucie, Manasota, Marion, Marvana, Michigan-Ohio Hybrid, Michi-

gan State Forcing, Morcross Surprise Hybrid, Ohio W.R. Globe 3, Ohio W.R. 7, Orange Slicer, Pearson VF6 and VF11, Pinkshipper, Red Global, Red Top V9, Rio Grande, Riverside, Roma, Simi, Solid Red Strain B, Sunray, Texto 2, Tippecanoe, Tipton, Tucker's Forcing, Tuckcross O, VF 36, Wiltmaster, and W-R Jubilee. Check with a local grower, your county agent, or your extension horticulturist regarding the adaptability of these varieties to your area. Resistant *peppers*: College No. 6, and Mexican Chili No. 9. Resistance may break down at high temperatures (over 90° F.).

20. *Verticillium Wilt* — Widespread during cool, moist seasons, especially in northern states. Symptoms are very similar to *Fusarium Wilt*. Eggplant is commonly attacked. Root-feeding nematodes may encourage penetration of the wilt fungus. See figures 30A and B under General Diseases. *Control*: Crop rotation excluding tomato, pepper, eggplant, potato, melons, okra, bramble fruits, and strawberry. Use disease-free soil (pages 437-44), seed, and transplants. Resistant *tomato* varieties where adapted: Essar, Geneva 11, Grand Pak, Loran Blood, Pearson VF6 and VF11, Red Top V9, Riverside, Simi, VF36, and V.R. Moscow.
21. *Bacterial Wilt* — Mostly southern states or where southern-grown transplants are used. Whole plant is stunted, usually wilts rapidly. Plants die, usually without yellowing or spotting of the leaves. Inside of stem is dark brown and water-soaked near the ground line. *Control*: Plant disease-free seed or transplants early in the season in disease-free soil which is well-drained. Destroy the first infected plants. Collect and burn crop debris after harvest. Four- or 5-year rotation in southern states, excluding tomato, pepper, eggplant, potato, and related plants. Grow resistant varieties where available and adapted. Somewhat resistant *eggplant* variety: Florida Market.
22. *Seed Rots, Damping-off, Stem and Collar Rots, Foot Rot* — Cosmopolitan. Seeds rot. Stand is thin. Seedlings wilt, wither, may collapse and die from a rot at the soil line. Canker at the base of the stem girdles and kills the foliage beyond. Mold growth may develop on affected parts. *Control*: Treat seed as for Bacterial Spot (above) then plant in well-drained, clean or sterilized soil (pages 437-44). Spray seedlings in the seedbed or flats at 5- to 7-day intervals, using captan ($1\frac{1}{2}$ tablespoons per gallon), ziram, or ferbam ($2\frac{1}{2}$ tablespoons per gallon). Spray both soil and plants. Use 5 gallons of spray to cover 100 square feet of surface. For *pepper* use a mixture of captan and Terraclor (PCNB). See the Shot-gun Soil Drench on page 92. Use $\frac{1}{3}$ quart per plant at transplanting time. Keep the seedbed soil on the dry side. Avoid overcrowding and overwatering. After harvest burn old plant debris. Otherwise, same as for *Septoria Leaf Spot* (above).
23. *Root-knot and Other Root-feeding Nematodes* (e.g., awl, burrowing, cyst, dagger, lance, nacobus, pin, reniform, ring, root-lesion, sheath, spiral, stem-rot, sting, stubby-root, stylet or stunt) — Widespread and serious, especially in southern states. Plants may be sickly, yellowed, and stunted with variously sized galls and swellings on the roots (Root-knot, Cyst nematodes). Roots may be stunted, stubby, "bushy," and discolored. Plants may wilt in dry weather but may recover at night for a time, then may die. See Figure 50D under General Diseases. Tomato, eggplant, most sweet peppers, and petunia are highly susceptible. *Control*: Plant certified, disease-free transplants grown in sterilized or fumigated soil or plant seed in similarly treated soil. Use heat, EDB, D-D, or Telone. Follow the manufacturer's directions. Many home gardens in the south are fumigated each year in the fall to protect against Root-knot and other nematodes (page 440). Check with a local grower, your county agent, extension horticulturist, or plant pathologist. *Pepper* varieties resistant to certain species of Root-knot: Anaheim Chili, Bush Red, Cayenne, Italian Pickling, and Santanka. Resistant *tomato* varieties may be available in the future.

24. *Southern Blight, Stem Rots or Cankers* — General and destructive in warm, moist weather. Plants may gradually wilt and die. Stem rots at or below the soil line. A cottony mold may be evident on the lower stem. Fruits that are on or near the soil may rot. *Control:* Carefully dig up and burn wilting plants together with several inches of surrounding soil, when first seen. Plant seedbed on clean or fumigated soil using Vapam, V.P.M. Soil Fumigant, chloropicrin, or Mylone. See pages 440-44. Four-year rotation or longer. Use disease-free transplants. Resistant *peppers*: Santanka and Tabasco.
25. *Phytophthora Blight, Fruit Rots* (eggplant, pepper, tomato, petunia) — Slight yellowing, sudden wilting and drying of leaves. Irregular, small to large, water-soaked areas on the fruit, which are wrinkled, sunken, and light gray or brown in color. A fine, cottony mold may grow on diseased areas. Pale to dark brown or dark green, water-soaked cankers may girdle the stems causing withering and dying of the parts above. Dark green spots on the leaves enlarge and become bleached. Seedlings damp-off. *Control:* Same as for Septoria Leaf Spot and Fruit Rots (both above). Plant in clean or sterilized soil. Resistant *eggplant* variety: Colossal Florida High Bush. Resistant *pepper*: Oakview Wonder. *Tomato* varieties also differ in resistance. Avoid sprinkling the foliage.
26. *Root Rots* — Plants stunted. Tend to wilt in hot weather or in bright sun. Roots are discolored and later rot away. Yield is reduced. Often associated with nematodes. *Control:* Same as for Seed Rot and Root-knot (both above). Avoid deep and close cultivations. Hilling up the soil around the base of the plant may help. Keep plants growing vigorously through proper fertilization and watering during dry periods. *Peppers* resistant to Phytophthora Root Rot may be available soon.
27. *Chlorosis* — Common in very acid or in alkaline soils. The foliage turns yellow, yellow-green or pale green, especially between the veins. Plants are often stunted. *Control:* Add 2 teaspoons of ferrous (iron) sulfate to each gallon of water in several Septoria Leaf Spot sprays as needed. Maintain balanced soil fertility based on a soil test.
28. *Downy Mildew, Blue Mold* (eggplant, pepper, tobacco, tomato) — Southern states, chiefly in the seedbed. Seedlings show pale green to yellow or brown spots on the upper leaf surface. A delicate, white to pale blue mold covers corresponding spots on the lower leaf surface. Seedlings are killed. Seedbed may appear "scalded." Leaves on older plants shrivel and drop early. Plants usually recover when the weather becomes warm and dry. *Control:* Same as for Seed Rot (above). Grow eggplant, pepper, and tomato seedlings as far away from tobacco seedbeds as possible.
29. *Psyllid Yellows, Purple Top* — Plants are stunted. New growth is yellowed after feeding of psyllid insects occurs. Prior growth remains normal. Leaves formed later are purplish, stunted, curled upward, and leathery. Terminal leaves turn a reddish-purple. Fruit yield is reduced. See also under Potato. *Control:* Spray with malathion and DDT or methoxychlor to control psyllids.
30. *Puffing, "Pops"* (tomato) — Gulf states, especially on winter and spring crops. Irregularly shaped fruits with large, air-filled cavities inside. Angular "corners" occur on green fruit. *Control:* Avoid planting susceptible varieties: Marglobe, Pritchard, and Urbana.
31. *Blossom Drop* (primarily tomato) — Fruits fail to set, especially on early flower clusters. Yield is reduced. Usually caused by high or low temperatures, low humidity, hot dry winds, diseases, or an overabundance of nitrogenous fertilizer. *Control:* Set plants early. Plant adapted varieties least sensitive to temperature changes. Check with a local grower, your county agent, or your extension horticulturist. Maintain an adequate supply of soil nutrients and moisture.

32. *Leafroll* (tomato) — The older and lower leaves roll upward and inward following extended periods of wet weather. The leaves become stiff and leathery. The disease later progresses up the plant. *Control:* Same as for Blossom-end Rot (above).
33. *Blight, Anthracnose* (butterfly-flower) — Small, water-soaked spots develop on the stems and petioles. Later, the rapidly growing shoots wilt, turn brown, and die back from the tips. Girdling cankers often develop on the older stems causing yellowing and death of the foliage beyond. Small brown spots occur on the leaves. *Control:* Prune and burn affected parts. Spray as for Septoria Leaf Spot (above). Start when the first spots appear.
34. *Powdery Mildew* (primarily butterfly-flower, eggplant, petunia, salpiglossis, tobacco, tomato, tree-tomato) — Powdery, white blotches on the leaves. *Control:* If necessary, apply sulfur or Karathane.
35. *White Smut* (browallia, Chinese lanternplant, groundcherry) — See (13) White Smut under General Diseases.
36. *Leafy Gall, Fasciation* (butterfly-flower, petunia, tobacco) — Uncommon. Abnormal, swollen, fleshy shoots with numerous, deformed, leaflike structures. See (20) Leafy Gall under General Diseases. *Control:* See under Pea.
37. *Crown Gall, Hairy Root* (Jerusalem-cherry, nightshade, tomato) — Rough, swollen galls on the stem near the soil line. *Control:* Carefully dig up and burn infected plants. Do not replant in the same location for 3 years without first drenching the soil with Vapam or V.P.M. Soil Fumigant.
38. *Rust* (eggplant, petunia, purple-flowered groundcherry) — Small, yellowish pustules on the leaves. *Control:* Keep down wild grasses which are the alternate hosts. Spray as for Septoria Leaf Spot (above).
39. *Web Blight* — Southeastern states. See under Bean.
40. *Scab* (eggplant) — See under Potato.
41. *Black Walnut Injury* — Plants growing under black walnut trees wilt and die. Closely resembles Fusarium Wilt (above). *Control:* Avoid growing within 50 feet of these trees.
42. *Tomato Crease Stem* — Southern states. Plants dwarfed, rigidly upright, and bunched. The upper parts of certain main stems develop flattened areas with deep longitudinal creases. A brown discoloration commonly occurs near the creases. *Control:* Plant in well-drained soil. Avoid the use of excessive amounts of nitrogenous fertilizer before the plants have many fruits larger than an inch in diameter. Resistant variety: Stokesdale.
43. *Stem Nematode* (groundcherry) — See under Phlox.
44. *Oedema* — Indoor problem. See under Begonia and Cabbage.
45. *Blossom Blight* — See (31) Flower Blight under General Diseases.

TORCH FLOWER — See Chrysanthemum

TORCHLILY — See Redhot - pokerplant

TORENIA — See Snapdragon

TOYON — See Apple

TRACHELOSPERMUM — See Oleander

TRACHYMENE — See Celery

**TRADESCANTIA, WANDERING - JEW, SPIDERWORT (*Tradescantia*);
DAYFLOWER [CREEPING, VIRGINIA] (*Commelina*); ZEBRINA**

1. *Leaf Spots* — Spots of various colors, sizes, and shapes on the leaves. *Control*: Pick off and burn spotted leaves. If practical, spray several times, 10 days apart, during rainy periods. Use zineb or maneb.
2. *Gray-mold Leaf Blight* — See (5) Botrytis Blight under General Diseases.
3. *Root-knot* — Southern states and an indoor problem in northern states. See (37) Root-knot under General Diseases.
4. *Rust* — Reddish-brown to black, powdery pustules on the leaves. *Control*: Same as for Leaf Spots (above).
5. *Other Root-feeding Nematodes* (e.g., burrowing) — Often associated with sickly, declining plants. *Control*: Same as for Root-knot (above).

TRAGOPOGON — See Lettuce

TRAILING - ARBUTUS — See Heath

TRAILING FOUR - O'CLOCK — See Four - o'clock

TRANSVAAL DAISY — See Chrysanthemum

TREE CYPRESS — See Phlox

TREE - OF - HEAVEN (*Ailanthus*)

1. *Leaf Spots* — Widespread. Leaves variously spotted. *Control*: See under Maple.
2. *Wood Rots* — General. See under Birch, and (23) Wood Rot under General Diseases.
3. *Twig Blights, Cankers, Dieback* — Occasional. See under Maple.
4. *Verticillium Wilt* — Serious. Leaves wilt, turn yellow, and fall prematurely. Often only on one side of the tree. Branches slowly die. Trees may die suddenly or may die back gradually over a period of years. Winter injury may follow wilt. Yellowish-brown streaks occur in the wood just under the bark. *Control*: See under Maple. There is no effective control.
5. *Root Rots* — See under Apple.
6. *Black Mildew* — See (12) Sooty Mold under General Diseases.

TREEMALLOW — See Hollyhock

TREE PEONY — See Delphinium

TREEPOPPY — See Poppy

TREE - TOMATO — See Tomato

TRICHOSANTHES — See Cucumber

TRILLIUM [LARGE - FLOWERED, PAINTED, PURPLE, YELLOW] (*Trillium*)

1. *Leaf Spots* — Spots of various sizes, shapes, and colors on the leaves. If severe, leaves may wither and drop early. *Control*: If practical, apply zineb or maneb at about 10-day intervals during rainy periods.
2. *Leaf Smut* — Black, sooty pustules break out on the leaves. See (11) Smut under General Diseases.
3. *Stem Rot* — Plants wilt and wither. Stems discolor and rot at the base. *Control*: See under Delphinium, Stem Canker.

4. *Rust* — Small yellowish pustules on the leaves. Cutgrass (*Leersia*) is the alternate host. *Control*: Same as for Leaf Spots (above).

TRIPLET LILY — See **Brodiaeae**

TRITOMA — See **Redhot - pokerplant**

TRITONIA — See **Gladiolus**

TROLLIUS — See **Anemone**

TROPAEOLUM — See **Nasturtium**

TROUT - LILY — See **Erythronium**

TRUMPETCREEPER — See **Trumpetvine**

TRUMPETFLOWER — See **Bignonia**

TRUMPETTREE (*Tabebuia*); FLORIDA YELLOWTRUMPET or YELLOW - ELDER (*Stenolobium*); CAPE - HONEYSUCKLE (*Tecomaria*)

1. *Rust* (Florida yellowtrumpet, trumpettree) — Yellow, yellowish-orange, reddish-brown or black, powdery pustules on the leaves. *Control*: Collect and burn fallen leaves. If needed, spray several times, 10 to 14 days apart, starting a week before rust normally appears. Use ferbam or zineb.

2. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases.

3. *Anthracnose* (cape-honeysuckle) — Spots develop on the leaves. *Control*: Collect and burn spotted leaves. If needed, spray as for Rust (above).

TRUMPETVINE or TRUMPETCREEPER (*Campsis*); DOXANTHA

1. *Leaf Spots, Leaf Blight* — General. Spots of various sizes, shapes, and colors on the leaves. Leaves may wither and drop early. *Control*: Pick off and burn spotted leaves. If practical, spray during rainy periods, about 10 days apart, using zineb, maneb, or captan.

2. *Powdery Mildew* — White, powdery mold may cover the foliage in late summer and fall. *Control*: When disease appears, spray or dust several times, 7 to 10 days apart. Use sulfur, Karathane, or Acti-dione.

3. *Mistletoe* — See (39) Mistletoe under General Diseases.

4. *Root Rot* — See (34) Root Rot under General Diseases.

5. *Verticillium Wilt* — See (15B) Verticillium Wilt under General Diseases.

TSUGA — See **Pine**

TUBEROSE — See **Daffodil**

TULIP [COTTAGE, DARWIN, FRINGED, LADY, PARROT, PEONY - FLOWERED, TRIUMPH, WATERLILY] (*Tulipa*); AFRICAN - LILY (*Agapanthus*); GLORY - OF - THE - SNOW (*Chionodoxa*); SUMMER - HYACINTH (*Galtonia*); FRITILLARY [SCARLET, YELLOW], GUINEA - HEN FLOWER, CROWN IMPERIAL (*Fritillaria*); HYACINTH (*Hyacinthus*); CAPE - COWSLIP (*Lachenalia*); GRAPE - HYACINTH and PLUME HYACINTH (*Muscari*); STAR - OF - BETHLEHEM (*Ornithogalum*); STRIPED SQUILL (*Puschkinia*); SQUILL [BLUE - FLOWERED, SIBERIAN], STAR or WILD - HYACINTH, BLUEBELL OF ENGLAND (*Scilla*); STENANTHIUM

1. *Fire, Botrytis Blights* (hyacinth, tulip) — General on tulip in cool, wet spring weather. Emerging leaves may be twisted and rotted. *Hyacinth* leaf tips are dark



Fig. 175. Tulip fire.

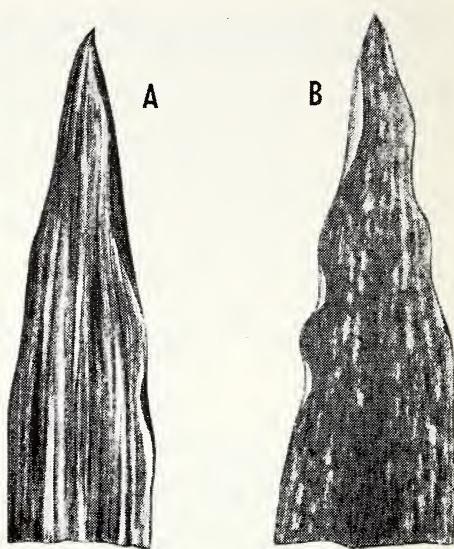


Fig. 176. A. Mottle-streaking of tulip, B. Tulip chlorosis.

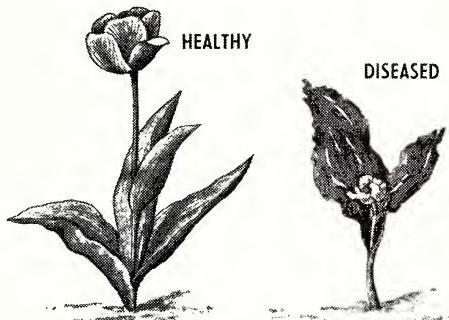
brown to almost black and shriveled. Petioles rot and may collapse. Small, yellowish-brown, sunken spots develop on *tulip* leaves and flower petals (Measles), with water-soaked margins. Spots enlarge and become whitish-gray or brown. *Tulip* leaves and flower stalk may collapse. Flower buds may not open. A grayish-brown mold grows on affected parts in damp weather. Often follows frost or hail injury. *Tulip* bulbs develop yellow or brown spots on the outer white scales. Small, black bodies (sclerotia) may develop on the outer brown husks of affected bulbs. See Figure 45A under General Diseases and Figure 175. *Control:* Plant only sound, blemish-free, healthy bulbs (without husks) in light, well-drained soil in a sunny spot. Three- or 4-year rotation. Avoid bruising, freezing, sunburning, or otherwise injuring bulbs. Avoid a wet mulch, overwatering, and overfertilization. Carefully remove and burn all infected plant parts as they occur plus 3 inches of surrounding soil. Dig bulbs in early summer during dry weather. Store at 40° F. and low humidity. Handle bulbs carefully to avoid injuries. Do not work among wet plants. Indoors, keep water off the foliage. Avoid forcing at too high a temperature. Increase air circulation. Remove fading flower heads. Remove and burn all tops as the leaves turn yellow. Spray once or twice weekly from when the leaves emerge to just before the flowers open. Use captan, dichlone, thiram, zineb, manebe, ferbam, or Terraclor plus detergent. Dust or spray the bed with Terraclor (PCNB) just before planting. Follow the manufacturer's directions. Yellow *tulips* have been reported as being less susceptible than the red.

2. *Bulb, Crown, and Root Rots* — Cosmopolitan. May be serious with plants dying in clumps. Shoots fail to emerge in the spring or produce stunted yellowish, purplish, or reddish leaves which later wilt, rot at the base, wither, and die. Roots decay; may be few or none. Flower stalks may rot at the base and collapse. Many infected bulbs fail to produce flowers. Bulbs are spotted and rot in the field or in storage. Affected areas may be covered with a black, blue-green, gray, pink, brown, or white mold growth. Rot may be chalky, powdery, firm, mushy or slimy and foul-smelling (Bacterial Soft Rot). See Figure 49D under General Diseases. *Control:* Same as for Fire (above). Cure bulbs after digging and then store in thin layers in a dry, well-ventilated location, following local recommendations. Check with a commercial

grower or your extension horticulturist. Discard spotted or rotted bulbs. Varieties may differ in resistance. Avoid forcing bulbs at high temperatures. Before planting or storage, dust bulbs with thiram, zineb, chloranil, or captan plus lindane. Control bulb mites by dipping *dormant* tulip bulbs in hot water (122° F.) for several minutes. Or soak as for Leaf, Bulb and Stem Nematode (below). Before planting, dust hole and edges with Terraclor (PCNB) using 1 pound of 20 per cent dust to 40 square feet. Follow the manufacturer's directions. Avoid overfertilizing with nitrogen. Four- to 5-year rotation.

3. *Flower Breaking, Mosaics* (cape-cowslip, fritillaria, hyacinth, squill, star-of-Bethlehem, summer-hyacinth, tulip) — General. Irregular stripes, spots, and blotches in tulip and hyacinth flower petals. *Tulip* petals may be feather-edged. Leaves and flower stem are often mottled or streaked with light and dark green, gray, or yellow areas. Plants lack vigor. May be stunted. Flowering may be prevented. *Rembrandt* (peppermint stick) *tulips* are naturally infected. Double-flowered *tulips* are more susceptible than single ones. Most pure white *tulip* flowers appear normal; some turn pink or red. Viruses easily spread by cutting infected then healthy flowers. See Figure 32B under General Diseases and Figure 176. *Control:* Destroy infected plants promptly, where feasible. Control aphids which transmit the viruses, using lindane or malathion. Avoid planting close to gladiolus, cucurbits, lilies, and solid-color tulips near Rembrandts. Keep down weeds.
4. *Leaf, Bulb and Stem Nematode, Ring Disease* (glory-of-the-snow, grape-hyacinth, hyacinth, squill, tulip) — Leaves stunted and deformed with yellowish to brown flecks and spots. Leaves often later shrivel, split, and die. Flowering is reduced. Bulb

Fig. 177. Stem and bulb nematode injury to tulip.



scales are swollen, spongy, may turn brown, gummy, and rot. *Hyacinth* bulbs, when cut across, show dark rings. Badly infested bulbs do not sprout. See figures 51B and 177. *Control:* Plant only large, firm, nematode-free bulbs in uninfested soil. If suspicious, soak dormant bulbs for 3 hours in hot water (110° F.) and formalin (1 part formaldehyde to 200 parts of water). Plant immediately. Avoid heavy, poorly drained soil. Dig up and burn infested bulbs and adjacent ones which appear healthy. Dig up and destroy 6 inches of soil surrounding these bulbs. Three-year rotation with non-bulb crops. See (20) Leaf Nematode and (38) Bulb Nematode under General Diseases.

5. *Hyacinth Yellows, Yellow Rot* — Widespread, often serious. Most common on forced plants. Elongated, yellow, water-soaked stripes on the leaves and flower stalks which later turn brown and shrivel. Infected bulbs show sunken, slimy, yellow pockets when cut across. Such bulbs are soft when squeezed. Leaves and flower stalks are easily pulled up. Flower heads are distorted and may not open. Bulbs often rot in the soil and never send up leaves. *Control:* Same as for Fire and Bulb

- Rots (both above). Cure bulbs properly. Keep away from wet plants. Varieties differ in resistance.
6. *Stem Rot, Southern Blight, Flower Spot* (squill, star-of-Bethlehem, tulip) — Flower stalk rots below the flower. Flower or entire plant may collapse, wither, and die. May be covered with a whitish mold in cool, moist weather. Serious on double varieties growing in shady, wet areas. *Control:* Same as for Fire (above).
 7. *Flower Stalk Collapse, "Topple," Loose Bud* (hyacinth, tulip) — Widespread. Primarily an indoor problem. Glassy, water-soaked spots form on the flower stalk or neck. Flower stalks may crack, shrivel, and collapse. Varieties differ greatly in resistance. *Control:* When forcing, avoid overwatering, sudden shifts in temperature, high temperatures, and high humidity. Ripen bulbs thoroughly before planting, especially after cold, wet seasons. Do not force bulbs too early. Plant shallowly in well-drained soil.
 8. *Flower and Leaf Smut* (grape-hyacinth and plume hyacinth, squill, tulip) — Dark, purplish-black, powdery pustules on the anthers of flowers and on the leaves. Flowers are spoiled. *Control:* Dig up and burn infected plants.
 9. *Frost Injury* — Late spring frosts may cause numerous, small, pale brown spots to form on the leaves and flower stalk. These spots may run together forming broad bands. Leaves may also show slits and be torn and ragged. *Control:* Protect against severe frosts.
 10. *Rust* (fritillaria, hyacinth, stenanthium) — Pale yellow, then brown, powdery pustules on the leaves. *Control:* Same as for Fire (above).
 11. *Tobacco Necrosis of Tulip* — Luckily only a few varieties are affected. Small to large, whitish, dead spots and streaks, surrounded by purple lines, form on poorly developed leaves, stems, and flowers. Leaves may be twisted, stunted, and shriveled. Plants usually die in patches. Seldom produce bulbs. *Control:* Plant in clean soil which has not grown tobacco or potato. Carefully sterilize the soil for indoor plants, since the causal virus is soil-borne (pages 437-44). Do not replant in outdoor beds without first sterilizing the soil with heat or chemicals.
 12. *Sunscald* (tulip) — Flower petals dry and shrivel, especially at the upper margins. *Control:* If practical, shade plants in hot, dry weather.
 13. *Winter Injury* (primarily tulip) — Shoots are twisted and abnormal. Bulbs rot. *Control:* Avoid planting bulbs late in the fall in a heavy soil where drainage is poor. See recommended cultural practices under Fire and Bulb Rots (both above).
 14. *Anthracnose* (tulip) — California. Small to large, oval to elongated, water-soaked spots on the leaves and stems. Spots later dry out and develop black margins. The centers of the spots are sprinkled with black masses of spores. *Control:* Same as for Fire (above).
 15. *Leaf Spot* (star-of-Bethlehem) — Sootlike spots on the leaves. If severe, leaves may be blackened and killed. *Control:* Same as for Fire (above).
 16. *Blindness* — Failure to flower. May be due to disease (see above), root failure in dry soil, too early forcing, or heating of bulbs in storage or transit.

TULIPTREE — See Magnolia

TUPELO — See Dogwood

TURFING DAISY — See Chrysanthemum

TURNIP — See Cabbage

TURQUOISE BERRY — See **Grape**

TURTLEHEAD — See **Snapdragon**

TUSSILAGO — See **Chrysanthemum**

TWINFLOWER — See **Pea** and below

TWINFLOWER (*Linnaea*)

1. *Leaf Spots, Tar Spot* — Spots of various sizes, shapes, and colors develop on the leaves during rainy seasons. *Control:* Collect and burn tops in the fall. Apply zineb, maneb, or captan at about 10-day intervals during rainy periods.

2. *Black Mildew* — See (12) *Sooty Mold* under General Diseases.

UDO — See **Acanthopanax**

ULMUS — See **Elm**

UMBELLULARIA — See **Avocado**

UMBRELLA - PINE — See **Pine**

UMBRELLAPLANT (*Cyperus*)

1. *Root-knot* — See (37) *Root-knot* under General Diseases. *Control:* Pot plants in sterilized soil (pages 437-44).

UMBRELLAWORT — See **Four - o'clock**

UNICORNPLANT — See **Proboscisflower**

UVULARIA — See **Lily**

VACCINIUM — See **Blueberry**

VALERIAN [COMMON, EDIBLE], GARDEN - HELIOTROPE (*Valeriana*); RED - VALERIAN or JUPITERS - BEARD (*Centranthus*); BEAKED and COMMON CORNSALAD, LAMBSLETTUCE (*Valerianella*)

1. *Leaf Spots* — Round to irregular spots of various sizes and colors on the leaves. *Control:* Pick off and burn infected leaves. Collect and burn tops in the fall. If practical, spray several times during rainy weather, at 10-day intervals, using zineb or maneb.

2. *Rusts (valerian)* — Yellow, yellowish-orange or dark, powdery pustules on the foliage. Alternate hosts: none or *Carex* spp. *Control:* Same as for Leaf Spots (above). Destroy sedges.

3. *Powdery Mildew* — Grayish-white, powdery mold patches on the upper leaf surface. *Control:* If necessary, spray two or three times, at 10-day intervals, using sulfur or Karathane.

4. *Stem Rot, Root Rots* — Stems rot at the soil line or below. Roots may decay. See under *Delphinium*.

5. *Curly-top* — See (19) *Curly-top* under General Diseases.

VALERIANELLA — See **Valerian**

VALLOTA — See **Daffodil**

VANDA — See **Orchids**

VANILLALEAF — See **Barberry**

VEGETABLE - MARROW — See **Cucumber**

VEGETABLE OYSTER — See **Lettuce**

VEGETABLE SPONGE — See **Cucumber**

VENUS - LOOKINGGLASS — See **Bellflower**

VERBASCUM — See **Snapdragon**

VERBENA — See **Lantana**

VERBESINA — See **Chrysanthemum**

VERONICA, VERONICASTRUM — See **Speedwell**

VERVAIN — See **Lantana**

VETCH, VICIA, VIGNA — See **Pea**

VETCHLEAF SOPHORA — See **Honeylocust**

VIBURNUM [**BIRCHLEAF, BURKWOOD, DAVIDI, DOUBLEFILE, FRAGRANT (CARLESI or KOREAN SPICE), ICHANG, JAPANESE, LAURESTINUS, LEATHERY, MAPLELEAF or DOCKMACKIE, PINK LEATHERY, RHYTIDOPHYLLUM, SANDANKWA, SIEBOLD, TEA]**, SNOWBALL [CHINESE, COMMON, JAPANESE], AMERICAN Highbush CRANBERRY, BLACKHAW, DWARF WITHE-ROD, EUROPEAN CRANBERRY - BUSH or Highbush CRANBERRY, ARROWWOOD, WAYFARING - TREE, WITHE - ROD, NANNYBERRY, POSSUMHAW (*Viburnum*); BEAUTY - BUSH, CHINESE BEAUTY - BUSH (*Kolkwitzia*)

1. *Powdery Mildew* (*viburnum*) — General. White, powdery mold may cover foliage in late summer and fall. Leaves may wither. *Control:* Spray two or three times, 10 days apart using Karathane. *Warning:* Do not use sulfur on viburnums, which may cause black spots on the leaves followed by heavy leaf fall within a few days.
2. *Bacterial Leaf Spot* (*viburnum*) — Widespread on various viburnums especially the variety *carlesi*. Round to irregular, water-soaked leaf spots which later turn dark and sunken. Irregular, sunken, brownish-black cankers develop on the young stems. Affected leaves may wither and drop early. *Control:* Carefully remove and burn infected plant parts as they occur. Spray 1 or 2 times weekly in cool, moist weather using fixed copper and spray lime (2 tablespoons each per gallon of water). Or use streptomycin (50 to 100 parts per million). Start when the leaves begin to unfurl.
3. *Fungus Leaf Spots, Leaf Blight, Spot Anthracnose, Downy Mildew* — General. Spots of various colors, shapes, and sizes on the leaves. If severe, leaves may wither and drop early. *Control:* If necessary, spray weekly with fixed copper and spray lime, zineb, or maneb.
4. *Gray-mold Blight, Shoot Blight* (*viburnum*) — Grayish-brown rotted spots on the leaves. Spots start at the margin and may later blight the whole leaf. Flower parts may be blighted. Twigs are killed. *Control:* Spray at least weekly, in cool damp weather, as for Fungus Leaf Spots (above).
5. *Verticillium Wilt, Dieback* (*viburnum*) — See under Maple, and (15B) Verticillium Wilt under General Diseases.

6. *Rusts* — Yellow, yellow-orange, reddish-brown, or black pustules on the leaves. *Control*: Not usually needed. Spray as for Fungus Leaf Spots (above).
7. *Root Rots* — Plants decline, lack vigor, may die back. Often associated with nematodes (e.g., dagger, pin, ring, root-lesion, spiral, stem or rot, stylet or stunt). See under Apple, and (34) Root Rot under General Diseases.
8. *Wood Rot* — See under Birch, and (28) Wood Rot under General Diseases.
9. *Root-knot* — Viburnums are quite susceptible. See under Peach, and (37) Root-knot under General Diseases.
10. *Crown Gall* — See under Apple, and (30) Crown Gall under General Diseases.
11. *Collar Rot, Stem Canker or Girdle* — See under Dogwood and Currant.
12. *Stem or Branch Gall, Twig Canker, Dieback* — Unimportant. Knoblike galls on the stems. Stems may die back. *Control*: Cut out and burn galls. Swab or dip pruning shears in 70 per cent denatured alcohol between cuts.
13. *Chlorosis* — Occurs in very acid or in alkaline soils. See under Maple.
14. *Thread Blight* — Southeastern states. See under Walnut.

VINCA, PERIWINKLE [BIGLEAF, COMMON or SMALL, DWARF, MADAGASCAR], GROUND - MYRTLE (*Vinca*); AMSONIA

1. *Gray-mold Blight, Botrytis Blight* — Brown or black spots on the leaves extending inward from the margin. May later cover the whole leaf. Affected areas are covered by a coarse gray mold in damp weather. *Control*: Space plants. Keep water off the foliage when watering. Plant in a sunny spot in well-drained soil where air circulation is good. Avoid a wet mulch. Spray or dust as for Dieback (below).
2. *Dieback, Stem Canker, Leaf Spots, Leaf Mold* — Leaves are spotted. Drop early. Stem cankers may kill out plants in patches. Shoot tips beyond the cankers wilt, darken, and die back. *Control*: Pull or prune out and burn seriously infected plants or plant parts when first seen. Use only disease-free stock from a reputable nursery. Spray at 10- to 14-day intervals, starting when the buds open, using captan, zineb, ferbam, dichlone, or fixed copper. Otherwise, same as for Gray-mold Blight (above). Drenching the soil in affected spots with a 1:1,000 solution of corrosive sublimate, Semesan (1 tablespoonful per gallon), or Terraclor 75 may be beneficial. Or fumigate the soil before planting (pages 440-44).
3. *Root and Stem Rot* — Roots and stems decay. May closely resemble Dieback and Stem Canker (both above). Sometimes associated with nematodes (e.g., burrowing, root-knot). *Control*: Same as for Dieback (above).
4. *Aster Yellows, Curly-top, Mosaic* — Leaves are streaked or mottled, may curve downward. Plants and flowers are dwarfed. Blue flowers may show white streaks (Flower Breaking). Do not confuse with normal variegated periwinkle. *Control*: Pull up and burn infected plants when first found. Keep down weeds. Spray with a mixture of DDT and malathion to control aphids and leafhoppers that spread these viruses.
5. *Root-knot* — See (37) Root-knot under General Diseases.
6. *Rusts* — Rather rare. Once in a bed, rust may reappear each year. Underside of leaves sprinkled with yellow-orange, reddish-brown, or nearly black powdery pustules. Alternate hosts: Pines, marsh and cord grasses (*Spartina*), or none. *Control*: Pull up and burn infected plants. Spraying as for Dieback (above) should be beneficial.
7. *Black Ringspot* — See under Cabbage.

VIOLA, VIOLET — See Pansy

VIRGINIA COWSLIP — See Mertensia

VIRGINIA - CREEPER — See Grape

VIRGINIA SNAKEROOT — See Aristolochia

VIRGINS - BOWER — See Clematis

VITEX — See Lantana

WAFER ASH — See Hoptree

WAHOO — See Bittersweet

WALKINGLEAF — See Ferns

WALLCRESS, WALLFLOWER — See Cabbage

WALL PEPPER — See Sedum

WALNUT [BLACK, CALIFORNIA, CALIFORNIA BLACK, EASTERN BLACK, ENGLISH or PERSIAN, HINDS, JAPANESE], BUTTERNUT or WHITE WALNUT (*Juglans*); PECAN, HICKORY [BITTERNUT, KINGNUT or BIG SHELLBARK, MOCKERNUT or WHITE, PIGNUT, SHAGBARK, WATER] (*Carya*)

1. *Anthracnose, Leaf Blotch, Leaf Spots* — General in wet seasons. Spots and blotches on the leaves of various sizes, shapes, and colors. Some spots may drop out leaving ragged holes. If serious, the leaves and fruit may wither and drop early. *Anthracnose* is an important nursery disease in the Southeast. *Control:* Spray pecan when buds burst open, leaves $\frac{1}{4}$ to $\frac{1}{2}$ grown, as *tips* of small nuts turn brown and 2, 4, and 6 weeks later. Use dodine (Cyprex) 5 tablespoons and 3 tablespoons of summer oil emulsion, per 10 gallons of water in the first 2 or 3 sprays. Use zineb (1 cup in 10 gallons) plus summer oil in the remaining sprays. Add DDT or methoxychlor and malathion to all sprays to control insects and mites. Spray butternut, hickories, and walnuts three or four times, 10 to 14 days apart, starting when the buds begin to open. Use zineb, ziram, maneb, phenyl mercury, Cyprex, or fixed copper. Collect and burn fallen leaves. Keep trees growing vigorously by pruning, watering, and fertilizing where practical. Avoid crowding trees. Varieties differ in resistance.
2. *Scab* (primarily pecan and hickories) — General and serious during rainy seasons. Dark brown to black patches on the nuts which become slightly sunken. Enlarging, round to irregular, olive-brown to black spots occur on the leaves. Often associated with the veins. If severe, infected leaves and nuts may drop early. See Figure 178. *Control:* Knock off and burn old shucks, leaves, and leaf stems after harvest. Apply the spray program for pecan as given under Anthracnose (above). Apply sprays at about 2-week intervals or just before rainy periods. Prune off low limbs. Space trees. Curtiss, Moneymaker, Success, Stuart, and Teche are *pecan* varieties that are normally resistant.
3. *Downy Spot, White Mold, Witches'-broom* — Widespread. Leaflets are stunted, turn yellow, then blacken and fall. A white, glistening, frosty "mildew" appears on the underleaf surface in early summer. Compact, bunchy clusters of shoots (witches'-brooms), 2 to 3 feet across, occur on the branches and trunk of shagbark hickory. Most evident during the winter. *Control:* Cut out and burn witches'-brooms. Collect and burn infected leaves. If practical, spray as for Anthracnose and Scab (both above). Schley and a few other *pecan* varieties are normally highly resistant. Moneymaker and Stuart are very susceptible.
4. *Bunch Disease* (butternut, Japanese, English and eastern black walnuts, pecan, water hickory) — Eastern states. One or more branches, or the entire tree, show

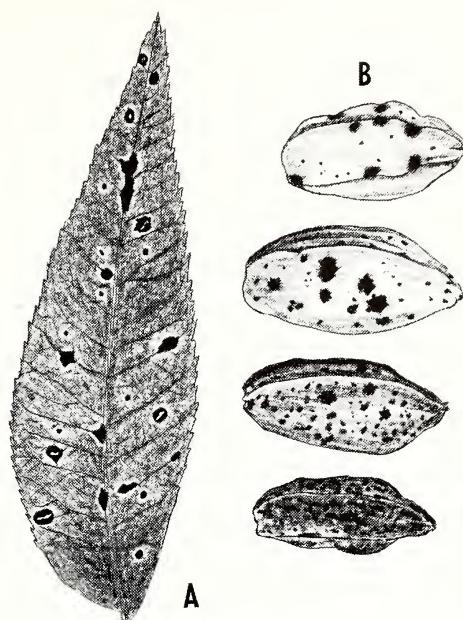


Fig. 178. Pecan scab. A. Leaf, B. Nuts.

bushy clusters of slender, willowy twigs (witches'-brooms). The "bunch" growths are most conspicuous in the spring and early summer since diseased branches often leaf out 2 weeks earlier than healthy ones. Shoots and branches die back. Leaves are dwarfed. Few, if any, nuts are produced. Stuart *pecan* has some resistance while Schley and Mahan are very susceptible. *Control:* Plant disease-free trees. Propagate only from healthy trees. Destroy infected wild pecans and water hickory trees growing nearby.

5. *Twig, Branch and Trunk Cankers, Dieback* — Widespread. Twigs and later the main branches or even the entire tree may gradually die back. New shoots or suckers may develop on the trunk. *Control:* Promptly cut out and burn dead and discolored, blighted wood well below any sign of infection. Keep trees vigorous. See under Anthracnose (above). Destroy badly infected trees.
6. *Crown Gall* — Widespread. Rough, irregularly swollen galls on the base of the trunk or roots. Trees lack vigor. Make poor growth. Leaves may turn yellow. Young trees may die. *Control:* Destroy severely infected trees. See (30) Crown Gall under General Diseases. In walnuts, remove all the gall tissue to the healthy wood underneath. Then paint the entire area with a solution of Elgetol (1 part) and methanol (4 or 5 parts) diluted 9 times with water. Plant disease-free nursery stock.
7. *Rosette, Zinc Deficiency, Little Leaf* — Young leaves on the tips of the upper branches are crinkled and mottled with yellow. Later, the leaflets are dwarfed and twisted, become narrowed, harden, turn reddish-brown and drop off. Healthy growth usually occurs below these affected tips. Later the symptoms may appear on the lower branches. Sometimes only certain limbs are affected. Shoots may die back from the tips and form bunchy "rosettes." Nut production is decreased. *Control:* Spray pecans three times with 36 per cent zinc sulfate (3 tablespoons per

gallon) 1, 2, and 3 months after the buds open. Or apply zinc chelate sprays according to the manufacturer's directions. May apply with the regular pest sprays. Check with a local grower, nurseryman, or your extension horticulturist. Zinc sulfate or zinc chelate may also be applied to the soil in February or March. Use 5 to 10 pounds per tree of zinc sulfate or 1 to 2 pounds of zinc chelate. Alkaline and neutral soils require much heavier rates than acid soils for a comparable response.

To correct zinc deficiency in walnuts use strips of galvanized 18 or 20 gauge sheet metal, 2 inches long and about $\frac{3}{4}$ inch wide. Drive these at 2-inch intervals into the wood of either the limbs or main trunk of the tree. Insert in horizontal bands around the tree parallel to the grain of the wood. Six bands per tree trunk or limb should be inserted. On trees larger than 10 inches in diameter, drive the strips into the limbs, not the trunks. Headless, galvanized nails may be used in place of the strips. Use 5 or 6 nails to each strip of metal. Varieties may differ in susceptibility.

8. *Root Rots, Blackline* — Cosmopolitan. Several rots are more frequent on English or Persian walnuts grafted on black walnut than on their own rootstocks. Often associated with nematodes (e.g., awl, dagger, lance, pin, ring, root-lesion, spiral, stubby-root, stylet or stunt). See under Apple, and (34) Root Rot under General Diseases. Certain more vigorous English or Persian walnut seedlings, e.g., Mangregian, are recommended for rootstocks in place of black walnut, at least in Oregon.
9. *Wood and Heart Rots, Trunk Decay, Branch Wilt* — Cosmopolitan. See under Birch, and (23) Wood Rot under General Diseases. Decay of wood occurs around and through wounds. *English walnut* varieties resistant to Branch Wilt (*Hendersonula*): Blackmer, Concord, Eureka, and Meylan. Both northern and southern California black walnuts are highly resistant to Branch Wilt.
10. *Nut Molds, Storage Molds* — Pink, gray, black, bluish-green or brown molds appear first on the shell but soon penetrate and destroy the kernel inside. *Control:* Store only sound nuts at about 38° F. and 90 per cent relative humidity. Spray as for Scab (above).
11. *Powdery Mildews* — General. Powdery, grayish-white mold on the leaves, young shoots, and nuts. If severe, leaves may drop early. *Pecan* nuts infected early in the season may split prematurely, causing shriveled kernels. *Control:* Where serious, apply sulfur or Karathane twice, 10 days apart. Most *pecan* varieties are resistant.
12. *Bacterial Blight of Walnuts* — Most serious on English (Persian) walnut along foggy coasts, or during rainy seasons. Small, angular, water-soaked spots form on the young leaves which turn reddish-brown to black. Spots may run together, distorting the leaves. Black, elongated, slightly sunken spots or streaks occur on the young shoots. If girdled, shoots die back. Infected buds turn dark brown to black and die. Blackish-brown, sunken spots form on the green nuts. Kernels in infected nuts may darken and shrivel. Young infected nuts usually drop early. Male catkins may be killed or produce contaminated pollen. See Figure 16D under General Diseases. *Control:* If practical, apply streptomycin (50 parts per million), fixed copper, or a mixture of both according to the manufacturer's directions. Two or three applications are needed between when 1 and 40 per cent of the female (pistillate) flowers are showing. Also apply several postbloom dusts or sprays just before rains in the spring and early summer. If you live in a commercial nut-growing area, follow the spray program published by your agricultural experiment station or cooperative extension service. Plant disease-free trees. Cut and burn badly infected shoots. Varieties differ in resistance. Ehrhardt, Eureka, Howe, and San Jose English (Persian) walnuts are resistant.

13. *Thread Blight* — Southeastern states in damp areas where plants are crowded and neglected. Small, dark masses (sclerotia) form on the twigs and leaf stems. Whitish fungus threads (hyphae) spread from these to the lower surface of the leaflets. Infected leaflets discolor and wither. The dead leaves become matted and hang by spiderweb-like threads until frost kills the fungus. *Control:* Same as for Anthracnose and Scab (both above).
14. *Root-knot* — See (37) Root-knot under General Diseases.
15. *Mistletoe* — See (39) Mistletoe under General Diseases.
16. *Collar Rots* — Irregular, brown to black cankers form at the crown. Trees sickly and stunted with thin, yellowish-green foliage. The nut crop may be heavy the year before death occurs. *Control:* See under Dogwood. Grow walnuts grafted on Persian or Paradox rootstocks.
17. *Sooty Mold* — See (12) Sooty Mold under General Diseases.
18. *Leaf Scorch, Sunscald* — See under Maple.
19. *Boron Deficiency, Dieback, "Snake Head"* — Western states. Large, irregular, dark brown spots develop between the leaf veins. Elongate, leafless shoots often evident in the tops of affected trees. Nuts may drop when the size of large peas. *Control:* Apply borax to the surface of the soil under the "drip line." Use 2 to 3 pounds for each tree 12 to 14 years old and 4 to 5 pounds for trees 18 to 25 years old. If only partial control is obtained, use $\frac{1}{2}$ the original amount of borax the following year. Check with your extension horticulturist.
20. "*Mouse Ear*" (*Little Leaf*), *Manganese Deficiency* — Southeastern states. Occurs in neutral or alkaline soils. Leaves are blunt at the tips instead of pointed. Where severe, leaflets are rounded and dwarfed (*Mouse Ear*). Only certain limbs may be affected. Nut production may be decreased. *Control:* Spray trees with 1 or 2 per cent manganese sulfate or apply 2 to 4 pounds of manganese sulfate to the soil of mature trees. Check with your extension horticulturist if you suspect this deficiency.
21. *Winter Injury, Sunscald* — See under Apple and Elm.
22. *Spanish Moss, Gray Moss* — A pest on trees in southern coastal areas, especially near live oak trees. Most troublesome in neglected orchards. *Control:* Keep trees growing vigorously through fertilization and a thorough pest control program. Apply a dormant spray of copper sulfate and calcium arsenate (1 pound of each per 10 gallons of water) for 3 consecutive years.
23. *Felt Fungus* — Southeastern states on neglected trees. Purple-black, feltlike growth on the bark. Associated with scale insects. *Control:* See under Hackberry.

WANDFLOWER — See Iris

WASHINGTONIA — See Palms

WATERCRESS — See Cabbage

**WATERLILY [AMERICAN or FRAGRANT, MAGNOLIA or TUBEROUS],
YELLOW PONDLILY (*Nuphar, Nymphaea*); LOTUS [AMERICAN,
HINDU] (*Nelumbo*)**

1. *Leaf Spots* — Spots of various sizes, shapes, and colors on the leaves. Leaves may curl up and wither. *Control:* Pick off and burn spotted leaves. If practical, spray several times during wet periods, using zineb, maneb, or fixed copper.
2. *White Smut* (pondlily, waterlily) — Pale yellowish spots on the leaves which are filled with dark brown to black, powdery masses. *Control:* Same as for Leaf Spots (above).

3. *Leaf and Stem Rot* (waterlily) — Foliage wilts and withers from a rotting of the leaf bases and stem. *Control:* Where feasible plant in sterilized soil. See pages 437-44 in the Appendix.

WATERMELON — See Cucumber

WATSONIA — See Iris

WAXBERRY — See Snowberry

WAXGOURD — See Cucumber

WAXMYRTLE [COMMON or CANDLEBERRY, PACIFIC or CALIFORNIA BAYBERRY], BAYBERRY, EVERGREEN BAYBERRY, SWEETGALE (*Myrica*)

1. *Leaf Spots* — Spots of various sizes, shapes, and colors on the leaves. If severe, leaves may wither and drop early. *Control:* Pick off and burn spotted leaves. If practical, spray several times during rainy periods, at 10-day intervals, using ferbam, zineb, maneb, or fixed copper.
2. *Rusts* — Bright orange, reddish-brown or black, powdery pustules on the leaves. Alternate hosts include white-cedar or pines. *Control:* Spray as for Leaf Spots (above).
3. *Sooty Mold, Black Mildews* (waxmyrtle) — Gulf states. Black, moldy patches on the leaves. *Control:* Spray with a mixture of malathion plus a fungicide as for Leaf Spots (above).
4. *Twig Blight* (sweetgale) — Twigs are blighted and die back. *Control:* Cut out and burn affected parts. Spray as for Leaf Spots (above).
5. *Virus Yellows* (bayberry) — Plants are stunted and bushy with few or no fruits. Older leaves are pale, yellowish, stunted, and leathery. Young leaves have wavy margins and tips. *Control:* Destroy infected plants.
6. *Root Rot* — See (34) Root Rot under General Diseases. May be associated with nematodes (e.g., ring).
7. *Seedling Blight* — See under Pine.

WAYFARING - TREE — See Viburnum

WEIGELA — See Snowberry

WELSH POPPY — See Poppy

WEST INDIAN GHERKIN — See Cucumber

WHITE - ALDER — See Sweet - pepperbush

WHITE BEAMTREE — See Apple

WHITEBRUSH — See Lantana

WHITE - CEDAR — See Juniper

WHITECUP — See Tomato

WHITE KERRIA — See Jetbead

WHITE SNAKEROOT — See Chrysanthemum

WHITLOWGRASS — See Cabbage

WICOPY — See Leatherwood

WILDBERGAMOT — See *Salvia*

WILD - HYACINTH — See *Tulip*

WILDOLIVE — See *Osmanthus*

WILD SWEET - WILLIAM — See *Phlox*

WILD TUBEROSE — See *Centuryplant*

WILLOW [**BABYLON WEEPING, BASKET or COMMON OSIER, BAY (LEAF)**
or LAUREL - LEAVED, BEARBERRY, BEBB, BLACK, BLUESTEM,
COLORADO, CONTORTED HANKOW, CRACK, DWARF or
SAGE, GOAT, GOLDEN, GRAY, HEARTLEAF, KOREAN, ROSE - GOLD
PUSSY, NIOBE, PACIFIC, PEACH LEAF, PRAIRIE, PUSSY, RED,
REDSTEM WHITE, RING - LEAF, ROSEMARY, SHINING, SILKY,
THURLOW WEEPING, WEEPING, WEEPING WHITE, WHITE or
HUNTINGDON, WISCONSIN WEEPING, and YELLOW], PURPLE OSIER,
DWARF PURPLE OSIER (*Salix*)

1. *Powdery Mildews* — General, but not serious. White, powdery mold growth on the leaves. Some leaves may wither and drop early. In the fall, the mildew may be sprinkled with tiny black dots, the sexual fruiting bodies of the mildew fungus. See (7) Powdery Mildew under General Diseases. Leaves are curled, may shrivel and drop early. *Control:* Spray two or three times, 10 to 14 days apart, starting when mildew is first evident. Use sulfur or Karathane.
2. *Leaf Spots, Spot Anthracnose, Gray Scab, Tar Spot* — Widespread, not serious. Small to large, round to irregular spots of various colors on the leaves. Leaves may wither and drop early. *Control:* Collect and burn fallen leaves. Spray several times, 10 to 14 days apart, starting when the buds begin to swell. Use zineb, captan, maneb, dichlone, phenyl mercury, fixed copper, or bordeaux (3-3-50).
3. *Leaf Rusts* — General. Lemon- to orange-yellow or reddish-brown, powdery pustules on the underside of the leaves. Later, dark brown to black powdery pustules appear on both leaf surfaces. Leaves may be distorted and drop early. Alternate hosts include larch, balsam, white, and alpine firs, garlic, gooseberry and currants, wild orchids, saxifrage, spindletree, or none. *Control:* Same as for Leaf Spots (above). If practical, spray a week or more before rust normally appears, using zineb, ferbam, maneb, fixed copper, or dichlone. Repeat 10 and 20 days later.
4. *Leaf Blight, Black Scab or Canker* — Serious in the northeastern states. Irregular, brown spots on the leaves covered on the underside with a dense brown or olive-green mold. Leaves then quickly wilt, blacken, and fall. Tips of young twigs may die back from brown to black cankers. Young trees may die if defoliated several years in succession. *Control:* Cut off and burn dead or blighted twigs. Keep plants vigorous by fertilization and watering during dry periods. Spray as for Leaf Spots (above). Weeping, pussy, bay, basket (common osier), and purple osier are resistant.
5. *Twig and Branch Cankers, Dieback, Twig Blights* — Widespread. Discolored, sunken, often sharply defined areas (cankers) develop on the twigs, branches, or trunk. Cankers enlarge and gradually girdle the part infected, causing death to the portions beyond. Trees may die after repeated attacks over several years. *Control:* Cut off and burn dead and cankered parts. Spray as for Leaf Spots (above) using fixed copper or bordeaux mixture (4-4-50). Willows vary greatly in susceptibility. Check with your nurseryman or extension plant pathologist. The black and peachleaf willows are reported as being resistant to *Cytospora canker* while the bay, basket,

- and weeping willows are resistant to *Black Canker* (*Physalospora*). Keep trees growing vigorously by fertilization and watering during drought periods.
6. *Wood and Heart Rots* — Cosmopolitan. See under Birch, and (23) Wood Rot under General Diseases. Spraying as for Leaf Blight (above) may be beneficial.
 7. *Crown Gall* — Widespread. Rough, irregular, "cauliflower-like" overgrowths on the roots, trunk, or branches. Usually found near the soil line. Trees lack vigor. Make poor growth. Leaves may turn yellow or branches and roots may die. *Control*: Destroy young infected trees and nursery stock. Do not replant the area with susceptible plants (see (30) Crown Gall under General Diseases) for at least 3 years. Avoid wounding the stem and roots of healthy trees since infections occur through wounds.
 8. *Root-knot* — See under Peach, and (37) Root-knot under General Diseases. Weeping willow is very susceptible.
 9. *Root Rots, Dieback, Cutting Rot* — Plants make poor growth. Foliage becomes pale. Tops die back. Roots or base of cuttings often decay. Internal root tissues may be discolored. May be associated with root-feeding nematodes (e.g., dagger, lance, root-knot, root-lesion, stylet or stunt). *Control*: Plant in clean or pasteurized soil (pages 437-44) which is well-drained.
 10. *Wetwood, Slime Flux* — See under Elm.
 11. *Sunscald, Winter Injury* — See under Apple and Elm.
 12. *Sooty Mold* — See under Linden, and (12) Sooty Mold under General Diseases.
 13. *Mistletoe* — See (39) Mistletoe under General Diseases.
 14. *Bleeding Canker* — Northeastern states. See under Beech and Maple.
 15. *Felt Fungus* — Southern states on neglected trees. Smooth, shiny, chocolate-brown to almost black growth over the bark. See under Hackberry.
 16. *Leaf Blister* — See under Birch, and (10) Leaf Curl under General Diseases.
 17. *Chlorosis* — Common in alkaline soils. See under Maple.

WINDFLOWER — See Anemone

WINTERBERRY — See Holly

WINTERCHERRY — See Tomato

WINTERCREEPER — See Bittersweet

WINTER DAFFODIL — See Daffodil

WINTERGREEN — See Heath

WINTER MELON — See Cucumber

WIRELETTUCE — See Chrysanthemum

WISHBONE FLOWER — See Snapdragon

WISTERIA, TREE WISTERIA, WISTARIA — See Honeylocust

**WITCH-HAZEL [CHINESE, COMMON or AMERICAN, JAPANESE, SPRING]
(*Hamamelis*); SWEETGUM (*Liquidambar*)**

1. *Leaf Spots* — Spots of various sizes, shapes, and colors on the leaves. Spots may enlarge and run together forming irregular blotches. Centers of spots may drop out giving the leaves a ragged appearance. Premature leaf fall may be heavy. *Control*: Where serious enough, spray three times, 2 weeks apart, starting when the leaves are

- $\frac{1}{4}$ inch long. Use zineb, maneb, ferbam, or fixed copper and spray lime (2 level tablespoons each per gallon of water).
2. *Powdery Mildews* (witch-hazel) — Eastern half of the United States. Grayish-white, powdery mold growth on the foliage in late summer and fall. *Control:* If serious, spray with sulfur or Karathane.
 3. *Wood Rots* — Cosmopolitan. See under Birch, and (23) Wood Rot under General Diseases.
 4. *Crown Gall* — See under Apple, and (30) Crown Gall under General Diseases.
 5. *Bleeding Necrosis of Sweetgum* — Eastern states. Trees "bleed" profusely. Resembles oil on the bark of the trunk and larger branches. The inner bark and sapwood underneath the oozing area is brown and dead. The foliage is thin. Terminal branches die back. Trees usually die in a short time. See also under Maple. *Control:* Remove and burn affected trees.
 6. *Sweetgum Blight, Leader Dieback* — Southeastern states. Leader branches die back. Trees die. *Control:* Same as for Wood Rots (above). Remove and burn dead branches. Check with your state or extension plant pathologist.
 7. *Root Rots* — See under Apple, and (34) Root Rot under General Diseases. May be associated with root-feeding nematodes (e.g., ring, root-knot, root-lesion, sheath, spiral, stubby-root, stylet or stunt).
 8. *Root-knot* — See under Peach, and (37) Root-knot under General Diseases.
 9. *Twig Cankers, Dieback* (sweetgum) — See under Maple.
 10. *Thread Blight* (sweetgum) — Southeastern states. See under Walnut.
 11. *Felt Fungi* (sweetgum) — Southern states. See under Hackberry.
 12. *Mistletoe* (sweetgum) — See (39) Mistletoe under General Diseases.

WITHE - ROD — See Viburnum

WOLFBERRY — See Snowberry

WOODBINE — See Grape and Snowberry

WOODSIA — See Ferns

WOODSORREL — See Oxalis

WOODWARDIA — See Ferns

WOODWAXEN — See Broom

WORMGRASS — See Sedum

WORMWOOD — See Chrysanthemum

WOUNDWORT — See Salvia

WYETHIA — See Chrysanthemum

XANTHORHIZA — See Clematis

XANTHOSOMA — See Calla

YAM [CHINESE or CINNAMONVINE, WILD], AIR POTATO (*Dioscorea*)

(This is the true yam. For sweetpotato see page 382.)

1. *Leaf Spots or Blotch, Anthracnose* — Small to large spots or blotches on the leaves. Often with a conspicuous margin. *Control:* Not usually needed. Pick off and burn.

spotted leaves. Spray during rainy periods, at about 10-day intervals, using zineb, maneb, or captan.

2. *Root-knot and Other Nematodes* (burrowing, root-lesion, spiral) — See (37) Root-knot under General Diseases. Tubers may rot. Roots and tops make poor growth.
3. *Storage Rots* — See under Sweetpotato. Affected areas may be covered with a blue-green or black fuzzy mold.
4. *Southern Blight, Crown Rot* — See (21) Crown Rot under General Diseases.

YARDLONGBEAN — See Pea

YARROW — See Chrysanthemum

YAUPON — See Holly

YAUTIA — See Calla

YELLOW - CEDAR — See Juniper

YELLOW - ELDER — See Trumpettree

YELLOW IRONWEED — See Chrysanthemum

YELLOW - JESSAMINE — See Butterflybush

YELLOW - POPLAR — See Magnolia

YELLOWROOT — See Clematis

YELLOW STAR — See Chrysanthemum

YELLOWTRUMPET — See Trumpettree

YELLOWTUFT — See Cabbage

YELLOWWOOD — See Honeylocust

YERBA - BUENA — See Salvia

YEW [CANADA or GROUND - HEMLOCK, CUSHION, ENGLISH (many horticultural forms), HATFIELD, HICKS, IRISH, JAPANESE (many horticultural forms), PACIFIC or WESTERN] (Taxus); PODOCARPUS

1. *Winter Injury* — Small twigs at the ends of branches turn reddish-brown to brown in late winter or early spring. *Control:* Shake off heavy snow or ice loads promptly. Protect from drying, winter winds and sun by planting in a protected location, erecting canvas or burlap screens, or try spraying with Wilt-Pruf or a similar material. Check with your extension horticulturist. Apply a mulch in late fall to prevent deep freezing plus alternating of freezing and thawing. Water plants thoroughly before applying the mulch. Prune out browned twigs in late spring.
2. *Dieback, Root Rot* — Growing tips turn yellow, later wilt and die. Plants gradually decline in vigor and die. Foliage becomes thin. A whitish mold may be evident beneath the bark under the soil surface. The bark on the deeper roots decays and falls away easily. May be associated with root-feeding nematodes (e.g., burrowing, dagger, lance, pin, ring, root-lesion, sheath, spear, spiral, sting, stubby-root, stylet or stunt). *Control:* Plant healthy, injury-free nursery stock in light, well-drained soil which is neutral (about pH 6.5). Make the soil lighter if possible. Add lime to an acid soil to raise the pH to 6.5. Completely remove and de-

stroy affected plants. Before replanting in the same area, drench the soil thoroughly with Vapam or V.P.M. Soil Fumigant following the manufacturer's directions. Avoid injuries to the roots or trunk. Maintain vigorous growth by fertilization, watering, and protecting adequately for the winter. Apply 2 sprays of dieldrin or chlordane to the lower parts of the plants, as well as the soil surface underneath, following the manufacturer's directions. Check with your extension entomologist regarding the timing of sprays for your area. These sprays control root weevils (Black Vine and Strawberry) which feed on the roots and foliage.

3. *Twig Blights* — See under Juniper. *Control:* Prune out and burn infected twigs. During rainy springs apply copper sprays at 2-week intervals.
4. *Needle Blights* — Needles are discolored and die back. *Control:* Rarely necessary. Spray as for Twig Blights (above).
5. *Crown Gall* — Rough, irregular, swollen galls at the base of the trunk or on the roots. Plant lacks vigor. Makes poor growth. *Control:* See under Apple, and (30) Crown Gall under General Diseases.
6. *Wood and Heart Rots* — See under Birch, and (23) Wood Rot under General Diseases.
7. *Brown Felt Blight* (yew) — Western states at high altitudes where snow is deep. *Control:* See under Pine.
8. *Seedling Blight, Damping-off* — See under Pine.

YUCCA: SPANISH - BAYONET, JOSHUA - TREE, ADAMS - NEEDLE or SILKGRASS, MOUNDLILY, SOAPWEED, CANDLES OF THE LORD (*Yucca*)

1. *Leaf Spots, Leaf Blight, Leaf Mold, Flower Blight* — General. Small to large spots, mostly more or less round in shape. Often zonate with a purple margin. If severe, large portions of leaves may die. Spots may also occur on the flowers. *Control:* Cut off and burn spotted leaves and flowers. Indoors, keep water off the foliage. If necessary, spray with a zineb, maneb, or copper fungicide before rainy periods.
2. *Root-knot* — See (37) Root-knot under General Diseases.
3. *Stem Rot* — Base of stem rots. May be covered with a white mold growth. See (21) Crown Rot under General Diseases.
4. *Rust* — Small, yellowish pustules on the leaves. *Control:* Same as for Leaf Spots (above).

ZANTEDESCHIA — See Calla

ZANTHOXYLUM — See Hoptree

ZAUSCHNERIA — See Evening - primrose

ZEBRINA — See Tradescantia

ZELKOVA — See Elm

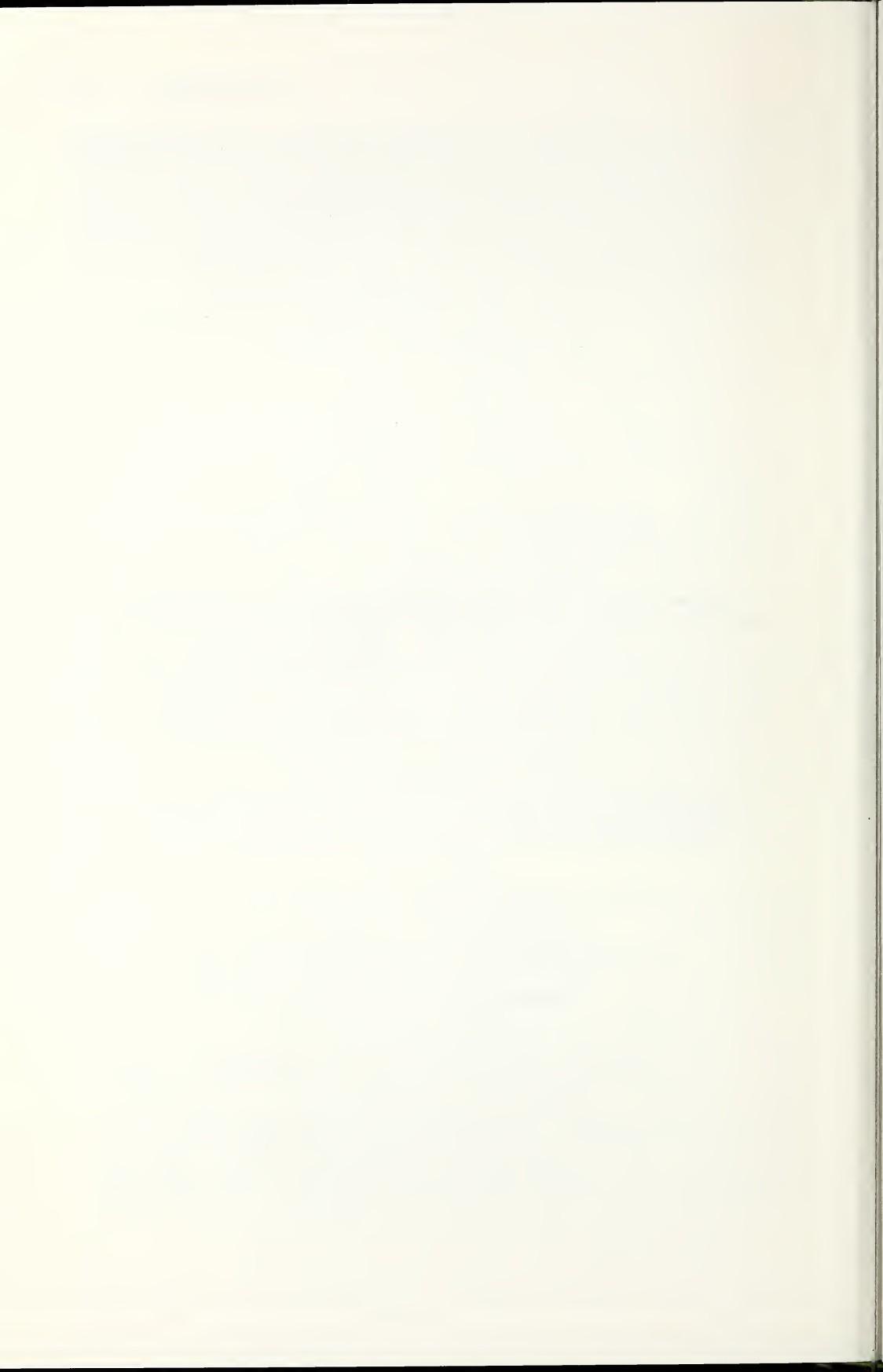
ZEPHYRANTHES, ZEPHYRLILY — See Daffodil

ZINNIA — See Chrysanthemum

ZOYSIA, ZOYSIAGRASS — See Lawnglass

ZYGOCACTUS — See Cactus

ZYGOPETALUM — See Orchids



Appendix

Useful units of measure . . .	417
Approximate rates of application equivalents . . .	418
Converting temperature from Fahrenheit to Centigrade . .	418
Modern fungicides	419
Equivalent volumes (liquid) for common measures	420
Amount (volume) of liquids required to prepare different amounts of spray mixtures at different dilutions	420
Amount (weight) of wettable powder required for preparing different amounts of spray mixture at different dosage levels	420
Amount (grams) of chemical required to prepare different amounts of spray mixture . .	421
Conversion table for use of materials on small areas .	421
Level tablespoons of fungicide for use in gallon lots of spray	422
Small amounts of liquid fungicide	422
Streptomycin formulations .	422
Spray or dust schedules for home-grown fruit	423
Approximate amount of spray material required for fruit trees of different sizes . . .	426
Gallons per acre required to spray orchards of different planting distances: square planting	426
Seed treatment	427
Precautions	427
Types of treatments	427
Hot water treatment times (in minutes) for seed and other plant parts	428
Seed treatment methods and materials for vegetables, flowers, trees, and shrubs .	431
Soil treatment methods and materials	437
Treatments using heat .	437
Treatments using chemicals	439
Home garden nematode control	440
Applying volatile disinfectants (fumigants) .	440
Materials, brands, controls, application, and remarks	442
Rates of application of sprays to row crops	445
Operating chart for tractor boom sprayers	445
Compatibility chart for common fungicides, insecticides, and miticides	446

USEFUL UNITS OF MEASURE

- A teaspoonful (tsp.) or tablespoonful (tbsp.) throughout this book refers to a level, standard measuring teaspoon or tablespoon.
80 drops = 1 teaspoonful (tsp.) or approximately $\frac{1}{6}$ fluid ounce (fl. oz.)
1 tablespoonful (tbsp.) = 3 teaspoonfuls (tsp.) = 15 milliliters (ml.) or cubic centimeters (cc.) = $\frac{1}{2}$ fluid ounce (fl. oz.)
1 cupful = 16 tbsp. = 8 fl. ozs. = 236.6 cc. = $\frac{1}{2}$ pint
1 pint (pt.) = 16 fl. ozs. (Note: 1 pint or quart dry measure is about 16 per cent larger than 1 pint or quart liquid measure.)
1 U.S. gallon = 4 quarts (qts.) = 8 pints

(pts.) = 3,785.3 ml. or cc. = 231 cubic inches = 8.3358 lbs. water capacity
1 liter = 1,000 ml. or cc. = approximately 1 qt., 1 fl. oz. (or 1.08 qts.)
1 pound (lb.) = 16 ozs. = 453.59 grams (gms.)
1 kilogram = 1,000 gms. = approximately 2 lbs. 2 ozs.
1 ounce (oz.) = 28.35 gms.
1 fluid ounce (fl. oz.) = 2 tbsp. = approximately 29.6 ml. or cc.
1 bushel of soil = 1.25 cu. ft.
1 mile = 5,280 ft. = 320 rods (rds.) = 1,609.35 meters
1 acre = 43,560 sq. ft. = 160 sq. rds. = 0.404 hectare
10 millimeters (mm.) = 1 centimeter (cm.) = 0.3937 inches
100 centimeters = 1 meter (m.) = 39.37 inches

**APPROXIMATE RATES OF
APPLICATION EQUIVALENTS**

(U.S. Measures)

- 1 ounce per square foot = 2,722.5 pounds per acre
- 1 ounce per square yard = 302.5 pounds per acre
- 1 ounce per 100 square feet = 27.2 pounds per acre
- 1 pound per 100 square feet = 435.6 pounds per acre
- 1 pound per 1,000 square feet = 43.6 pounds per acre
- 1 pound per acre = $\frac{1}{3}$ ounce per 1,000 square feet
- 5 gallons per acre = 1 pint per 1,000 square feet
- 100 gallons per acre = 2.5 gallons per 1,000 square feet

100 gallons per acre = 1 quart per 100 square feet
100 gallons per acre = 2.5 pounds per 1,000 square feet

**CONVERTING TEMPERATURE FROM
FAHRENHEIT TO CENTIGRADE AND
VICE VERSA**

To convert from *Fahrenheit* to *Centigrade*: Subtract 32 from the *Fahrenheit* reading, multiply by 5, and divide the product by 9. *Example*: $131^{\circ}\text{ F.} - 32 = 99 \times 5 = 495; 495 \div 9 = 55^{\circ}\text{ C.}$

To convert from *Centigrade* to *Fahrenheit*: Multiply the *Centigrade* reading by 9, divide the product by 5 and add 32. *Example*: $25^{\circ}\text{ C.} \times 9 = 225 \div 5 = 45; 45 + 32 = 77^{\circ}\text{ F.}$

TABLE 1 — MODERN FUNGICIDES

Common Name and Active Ingredient	Trade Names and Distributors	Principal Uses and Remarks
Captan N-trichloromethylthiotetrahydro-phthalimide	Captan 50-W, Captain 75 Seed Protectant, Captain 60-15 Seed Protectant, Captain Garden Spray, Captain 80 Spray-Dip (Stauffer), Orthocide 50 Wettable, Orthocide Fruit and Vegetable Wash, Orthocide 75 Seed Protectant (California Spray-Chemical Corp.), etc.	Excellent, safe fungicide for fruits, ornamentals, and vegetables to control leaf spots, blights, fruit rots, etc. Seed protectant for vegetables, flowers and grasses. Post-harvest dip for fruits and vegetables. Soil drench to control crown rot and seedling blights. Widely used in multipurpose sprays and dusts.
Chloranil Tetrachloro-p-benzoquinone	Spergon, Spergon Wettable, Spergon Seed Protectant (U.S. Rubber), Spergon Spray Powder (Niagara and General Chem.), Niagara Seed Protectant, etc.	Seed and bulb treatment for flowers, vegetables, and grasses. Soil drench for crown rot of flowers. Corm and bulb dip for flowers. Sprays and dusts for certain foliage diseases.
Dichlone 2,3-dichloro-1,4-naphthoquinone	Phygon, Phygon-XL, Phygon Seed Protectant (U.S. Rubber), Phygon-XL Micronized (Pittsburgh Plate Glass), Niagara Phygon, Phygon Wettable Powder (Gen.), etc.	Seed treatment for certain vegetables and flowers. Spray for certain blights and fruit rots of vegetables and fruits. Soil drench to control damping-off. Treat as directed.
Ferbam Ferric dimethylthiocarbamate	Fermate Ferbam Fungicide (Du Pont), Karbam Black (Sherwin-Williams), Carbamate (Niagara), Ferbam (Calif. Spray), Orchard Brand Ferbam (Gen.), Coronate (Pittsburgh Plate Glass)	General fungicide to control many foliage diseases of flowers, trees, shrubs, and fruits. Soil drench to control damping-off and seedling blights. Used in some multipurpose fruit sprays.
Maneb Manganese ethylene bisdithiocarbamate	Manzate Maneb Fungicide, Manzate 75 (Du Pont), Dithane M-22 (Rohm and Haas), etc.	General fungicide to control foliage diseases of vegetables, flowers, trees, some fruits. Very useful for tomato and potato. In multipurpose sprays.
Thiram (TMTD) Tetramethyl thiuram disulfide	Tersan 75, Thylate, Arasan 75, Delsan A-D (Du Pont), Thiram 50 Dust (U.S. Rubber), Panoram 75 (Morton), etc.	Seed and bulb treatment on vegetables, flowers, and grasses. Controls certain lawn diseases. Soil drench for crown rot and damping-off.
Zineb Zinc ethylene bisdithiocarbamate	Dithane Z-78 (Rohm & Haas), Parzate Zineb Fungicide, Porzate C (Du Pont), Ortho Zineb 75 Wettable, Ortho 4 or 6 Dust (Calif. Spray), Stauffer Zineb (Stauffer), etc.	Excellent fungicide for vegetables, fruits, flowers, trees, and shrubs. Also useful on lawns. Soil drench to control crown rots and root rots. In many vegetable and flower multipurpose mixes.
Ziram Zinc dimethyl thiocarbamate	Zerlate Ziram Fungicide (Du Pont), Karbam White (Sherwin-Williams), Z-C Spray or Dust (Niagara), Ziram (California Spray, Stauffer), etc.	General, safe fungicide. Useful for vegetables and ornamentals, especially tender seedlings. In many vegetable and flower multipurpose mixtures.

TABLE 2
EQUIVALENT VOLUMES (LIQUID) FOR COMMON MEASURES

Measuring Unit Used	Number of Units To Fill Measure in Column 1					
	Teasp.	Tablesp.	Cup	Pint	cc.	Liter
1 Teaspoonful . . .	1.00	0.33	0.021	0.010	4.9	0.0049
1 Tablespoonful . . .	3.00	1.00	0.663	0.031	14.8	0.0148
1 Fluid Ounce . . .	6.00	2.00	0.125	0.062	29.6	0.0296
1 Cup	48.00	16.00	1.000	0.500	236.6	0.2366
1 Pint	96.00	32.00	2.000	1.000	473.2	0.4732
1 Quart	192.00	64.00	4.000	2.000	946.3	0.9463
1 Gallon	768.00	256.00	16.000	8.000	3,785.3	3.7853
1 Liter	202.88	67.63	4.328	2.164	1,000.0	1.0000
1 Milliliter (cc.) . . .	0.20	0.068	0.0042	0.0021	1.0	0.0010

TABLE 3
AMOUNT (VOLUME) OF LIQUIDS REQUIRED TO PREPARE DIFFERENT AMOUNTS OF SPRAY MIXTURES AT DIFFERENT DILUTIONS

Dilution of Spray Required	Recommended Dosage of Chemical in 100 Gallons of Water			Amount of Material Required To Prepare Spray for					
				20 gallons		5 gallons		1 gallon	
	cups	pints	qts.	pints	cc.	cc.	tsp.	cc.	tsp.
1-3200 . . .	0.5	0.25	0.12	0.050	23.7	5.9	1.2	1.18	0.2
1-1600 . . .	1.0	0.50	0.25	0.100	47.7	11.8	2.4	2.37	0.5
1-800 . . .	2.0	1.00	0.50	0.200	94.6	23.7	4.8	4.73	1.0
1-400 . . .	4.0	2.00	1.00	0.400	189.3	47.3	9.6	9.46	1.9
1-200 . . .	8.0	4.00	2.00	0.800	378.6	94.6	19.2	18.93	3.8
1-100 . . .	16.0	8.00	4.00	1.600	757.1	189.3	38.3	37.86	7.7
1-50 . . .	32.0	16.00	8.00	3.200	1,514.2	378.6	76.6	75.71	15.3
1-25 . . .	64.0	32.00	16.00	6.400	3,028.5	757.1	153.2	151.42	30.6
1-10 . . .	160.0	80.00	40.00	16.000	7,571.0	1,893.0	383.0	378.60	76.5

TABLE 4
AMOUNT (WEIGHT) OF WETTABLE POWDER REQUIRED FOR PREPARING DIFFERENT AMOUNTS OF SPRAY MIXTURE AT DIFFERENT DOSAGE LEVELS

Recommended Dosages per 100 Gallons			Amount of Material Required To Prepare Spray Mixture							
			50 gallons		20 gallons		5 gallons		1 gallon	
lbs.	ozs.	gms.	ozs.	gms.	ozs.	gms.	ozs.	gms.	ozs.	gms.
0.25	4	113	2	56	0.8	23	0.20	6	0.04	1
0.50	8	227	4	113	1.6	45	0.40	11	0.08	2
1.00	16	454	8	227	3.2	91	0.80	23	0.16	5
1.50	24	681	12	340	4.8	136	1.20	34	0.24	7
2.00	32	908	16	454	6.4	182	1.60	45	0.32	9
3.00	48	1,362	24	681	9.6	272	2.40	68	0.48	14
4.00	64	1,816	32	908	12.8	363	3.20	91	0.64	18
5.00	80	2,270	40	1,135	16.0	454	4.00	113	0.80	23

TABLE 5

AMOUNT (GRAMS) OF CHEMICAL REQUIRED TO PREPARE DIFFERENT AMOUNTS OF SPRAY MIXTURE

Recommended Pound Dose per 100 Gallons	Grams of Material Required To Prepare *				
	100 gal.	50 gal.	20 gal.	5 gal.	1 gal.
0.25.....	113.4	56.7	22.7	5.7	1.1
0.50.....	226.8	113.4	45.4	11.3	2.3
0.75.....	340.2	170.1	68.0	17.0	3.4
1.00.....	453.6	226.8	90.7	22.7	4.5
1.25.....	566.9	283.5	113.4	28.4	5.7
1.50.....	680.3	340.1	136.1	34.0	6.8
1.75.....	793.7	396.8	158.7	39.7	7.9
2.00.....	907.1	453.6	181.4	43.4	9.1
2.50.....	1,133.8	566.9	226.8	56.7	11.3
3.00.....	1,360.6	680.3	272.2	68.0	13.6
4.00.....	1,814.1	907.1	362.8	90.7	18.1
5.00.....	2,267.7	1,133.8	453.6	113.4	22.7

* To convert to ounces or pounds divide by 28.35 or 453.59 respectively.

TABLE 6
CONVERSION TABLE FOR USE OF MATERIALS ON
SMALL AREAS

Rate per Acre	Rate per 1,000 Square Feet	Rate per 100 Square Feet
<i>Liquid Materials</i>		
1 pt.	3/4 tbsp.	1/4 tsp.
1 qt.	1 1/2 tbsp.	1/2 tsp.
1 gal.	6 tbsp.	2 tsp.
25 gal.	4 1/2 pts.	1 cup
50 gal.	4 1/2 qts.	1 pt.
75 gal.	6 1/2 qts.	1 1/2 pts.
100 gal.	9 qts.	1 qt.
<i>Dry Materials</i>		
1 lb.	2 1/2 tsp.	1/4 tsp.
3 lbs.	2 1/4 tbsp.	3/4 tsp.
4 lbs.	3 tbsp.	1 tsp.
5 lbs.	4 tbsp.	1 1/4 tsp.
6 lbs.	4 1/2 tbsp.	1 1/2 tsp.
8 lbs.	2 2/5 cup	1 3/4 tsp.
10 lbs.	1 1/2 cup	2 tsp.
100 lbs.	2 1/4 lbs.	1/4 lb.

TABLE 7
LEVEL TABLESPOONS OF FUNGICIDES FOR USE IN GALLON LOTS OF SPRAY

Fungicide	Pounds per 100 Gallons						
	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	4	6	8
Level tablespoons to use in 1 gallon of spray*							
Captan 50%, wettable powder....	$\frac{3}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$	$1\frac{1}{2}$	3		
Chloranil 96%, wettable powder (Spergon).....	$\frac{1}{2}$	1	$1\frac{1}{2}$	$2\frac{5}{8}$	4	$6\frac{1}{8}$	$8\frac{1}{2}$
Copper Sulfate (snow).....		$\frac{1}{3}$	$\frac{1}{2}$		$1\frac{1}{4}$		
Dichlone 50%, wettable powder (Phygon).....	$\frac{1}{3}$	$\frac{2}{3}$					
Ferbam 76%, wettable powder....	$\frac{5}{8}$	$1\frac{1}{4}$	$1\frac{3}{4}$	$2\frac{1}{2}$	5		
Fixed Copper 50%, metallic copper.....	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	1	2	3	4
Karathane-WD.....	$\frac{1}{3}$	$\frac{2}{3}$					
Maneb 80%, wettable powder....	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	1	2		
Omazene.....	$\frac{1}{2}$	1					
Phaltan 75%, wettable powder....	$\frac{3}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$	$1\frac{1}{2}$	3		
Semesan.....	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	1			
Spray Lime.....		$\frac{1}{2}$	1	2	4	6	8
Terraclor 75%, wettable powder..	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	4		
Thiram 65% (Thylate).....	$\frac{1}{3}$	$\frac{2}{3}$	1	$1\frac{1}{3}$	$2\frac{2}{3}$		
Thiram 75%, wettable powder....	$\frac{3}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$	$1\frac{1}{2}$	3		
Wettable Sulfur (dry).....	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	1	2	3	4
Zincb 65-75%, wettable powder..	$\frac{1}{3}$	$\frac{2}{3}$	1	$1\frac{1}{3}$	$2\frac{2}{3}$		
Ziram 76%, wettable powder....	$\frac{5}{8}$	$1\frac{1}{4}$	$1\frac{3}{4}$	$2\frac{1}{2}$	5		

* Tablespoon amounts are based on a level tablespoon containing $\frac{1}{2}$ ounce.

TABLE 8
SMALL AMOUNTS OF LIQUID FUNGICIDE

Amount of Liquid Fungicide Recommended for 100 Gallons of Spray	Amount of Fungicide to Use in 1 Gallon of Spray
12 gallons	32 tablespoons or 1 pint
10 gallons	$26\frac{3}{4}$ tablespoons or $\frac{4}{5}$ pint
1 gallon	$2\frac{1}{2}$ tablespoons
1 quart	$\frac{5}{8}$ tablespoon

TABLE 9
STREPTOMYCIN FORMULATIONS: NUMBER OF TEASPOONS PER GALLON OF DIFFERENT FORMULATIONS TO MAKE A 100 PARTS PER MILLION SOLUTION

Agri-mycin 100, 15% wettable powder..	$1\frac{1}{2}$
Agri-strep, 25.5% wettable powder.....	$\frac{3}{4}$
Miller Antibiotic Streptomycin Spray Powder, 8.5% wettable powder.....	$2\frac{1}{2}$
Ortho Streptomycin Spray, 17% wettable powder.....	$1\frac{1}{2}$
Phytomycin, 20% liquid.....	$\frac{1}{2}$

SPRAY OR DUST SCHEDULES FOR HOME-GROWN FRUIT

The schedules outlined below for tree, bush, and bramble fruits are average home fruit programs. Weather, disease, and pest conditions vary greatly from region to region in the United States. This makes absolute, fixed schedules impossible. Most commercial fruit growers use 20 to 40 per cent more sprays than are listed below. *There are no short cuts!* Supplement these fruit programs with those published by your state and available at your county extension office.

The multipurpose fruit spray (page 91) containing captan, methoxychlor, and malathion is recommended for all sprays or dusts except as noted below. This mixture can be used safely on most ornamentals, shrubs, flowers, vines, small trees, and lawns. If it doesn't give satisfactory results, ask local authorities (e.g., your county agent, extension plant pathologist, horticulturist, or entomologist) for more information.

Follow a complete spray or dust program. Two or 3 applications in the spring will not give satisfactory disease and insect control of most fruits.

Follow local, recommended, cultural practices regarding pruning, cultivation,

and mulching. Plant only what you can properly take care of. Unsprayed and uncared for fruit trees make good breeding places for disease-producing organisms and insect pests.

Remember to:

1. *Spray thoroughly* — Cover all above-ground plant parts, including both leaf surfaces with each spray. Use adequate pressure. Keep the spray mixture stirred to prevent settling. Wash out sprayer and hose thoroughly after using.

2. *Spray often* — Additional sprays will be needed during long wet periods. An inch of rainfall removes or reduces the effectiveness of the spray film. Temperatures above 90° F. shorten the period when the spray film is protective.

3. *Measure carefully. Use the amounts suggested* — A more concentrated spray may cause severe injury.

Apply dusts or sprays when there is little or no wind and the foliage is dry. Never make applications when freezing temperatures are expected. Follow all safety precautions outlined in Section 3. *Always read, understand, and follow the precautions listed on the package label.*

Pick up and dispose of dropped and rotted fruits promptly and destroy all diseased plant refuse.

TABLE 10
SPRAY OR DUST SCHEDULES FOR HOME-GROWN FRUIT

	Peach						
	Plum						
	Prune						
	Cherries						
	Nectarine						
	Apricot						
	Almond						
When to Spray	Apple	Pear					
	Crabapple	Quince					
DORMANT SPRAY Apply <i>before</i> buds show green at tips	Spray ¹						
GREEN TIP SPRAY When buds "broken," to show green tips	Spray ³	Spray					
PREBLOOM SPRAY When most blossom buds show color and <i>before</i> blossoms open	Spray ²	Spray ^{2,3}	Spray				
BLOOM SPRAY When flowers are open	Do not spray during bloom, or use just captan plus another fungicide ⁴						
PETAL-FALL SPRAY When 90 per cent of petals have fallen	Spray ⁸	Spray	Spray ^{2,3,8}				
1ST COVER SPRAY 10 days after petal- fall	Spray	Spray	Spray				
2ND COVER SPRAY 10 days after 1st cover	Spray						

TABLE 10

SPRAY OR DUST SCHEDULES FOR HOME-GROWN FRUIT (Continued)

When to Spray	Apple	Pear	Crabapple	Quince	Spray	Spray	Spray	Fruit pe-	Fruit begin-	Berries start	Spray ⁶	Just after
3RD COVER SPRAY								Dewberry	Boysenberry	Strawberry	Huckleberry	Gooseberry
10 days after 2nd cover												
4TH COVER SPRAY												
10 days after 3rd cover												
5TH COVER SPRAY												
10 days after 4th cover												
6TH COVER SPRAY												
10 days after 5th cover												

Fruit touching
in clusters

Fruit growing⁶

Fruit growing⁶

ADDITIONAL
COVER SPRAYS

Late maturing varieties Spray⁵

- Use ferbam, $2\frac{1}{2}$ tablespoons per gallon ($\frac{3}{4}$ cup in 5 gallons), on stone fruits as a dormant spray to control *Leaf Curl*, *Black Knot*, and *Plum Pockets*. The outdoor temperature must be above 40° F. or above when spray is applied.
- If *Rust* is a problem, add ferbam, zineb, or thiram (1 tablespoon per gallon; $\frac{1}{3}$ cup in 5 gallons) to the multipurpose spray. See Section 4 regarding timing of applications.
- If *Powdery Mildew* is a problem in your area add Karathane ($\frac{2}{3}$ teaspoon per gallon; 1 tablespoon in 5 gallons) or wettable sulfur (2 tablespoons per gallon; $\frac{1}{2}$ cup in 5 gallons). Some fruits like *blueberries*, *grapes*, *raspberries*, and certain *apple* varieties are sulfur-sensitive. Use sulfur with caution on these crops.
- Do not apply the multipurpose spray during bloom or pollinating insects will be killed. To control *Rust*, *Brown Rot*, *Blossom Blight*, *Scab*, *Mold Blight*, and other diseases which attack during the bloom period, apply a mixture of captan and either ferbam, zineb, or thiram (1 tablespoon of each per gallon). Spraying just before wet periods is preferred.
- Do not apply the multipurpose spray within a week of harvest. *Cablan* alone may be used right up to harvest and even as a dip after picking to

protect against *Fruit Rots*. A mixture of captan and zineb ($1\frac{1}{2}$ tablespoons of each per gallon) is recommended for cover sprays on *apples* to control summer diseases.

Cherries, *raspberries*, other brambles, *strawberries*, *currants*, *gooseberries*, and *blueberries* should be sprayed after harvest to protect the growth for next year's crop. See under plant involved in Section 4.

Add zineb or fixed copper to the multipurpose spray for *grapes*, in afterbloom sprays, if *Douay Mildew* is found.

To control *peach* and *apple* borers, thoroughly spray or paint the trunk and scaffold branches 3 times at 20-day intervals, using DDT (4 heaping tablespoons of 50 per cent powder in a gallon of water). Check with your county agent or extension entomologist regarding the timing of these applications.

Use liquid lime-sulfur alone in the first two sprays for *raspberries* and *blackberries* to control *Anthonomus* and *Spiraea Blight*. Use 4/5 pint per gallon, or 2 quarts in 5 gallons of spray. Use the multipurpose spray for all later applications.

TABLE 11
APPROXIMATE AMOUNT OF SPRAY MATERIAL
REQUIRED FOR FRUIT TREES OF
DIFFERENT SIZES

Height in Feet	Spread in Feet	Gallons per Application
5-8	3-6	½-1
8-10	4-8	1-2
10-15	8-15	4-5
15-20	15-25	8-10
20-25	25-30	12-15
25-30	30-40	18-20

TABLE 12
GALLONS PER ACRE REQUIRED TO SPRAY ORCHARDS OF DIFFERENT PLANTING DISTANCES:
SQUARE PLANTING

Distance Between Trees in Feet	Desired Gallons Per Tree							
	2	5	7	9	10	12	15	20
	Gallons Per Acre Required							
18.....	268	670	938	1,206	1,340	1,608	2,010	2,680
20.....	218	545	763	981	1,090	1,308	1,635	2,180
22.....	180	450	630	810	900	1,080	1,350	1,800
24.....	150	375	525	675	750	900	1,125	1,500
25.....	140	350	490	630	700	840	1,050	1,400
30.....	96	240	336	432	480	576	720	960
35.....	72	180	252	324	360	432	540	720
40.....	54	135	189	243	270	324	405	540
45.....	44	110	154	198	220	264	330	440
50.....	34	85	119	153	170	204	255	340

SEED TREATMENT*

The value of chemical treatment of garden seed has been proved repeatedly. Disease-producing organisms on and in the seed are killed. Protection is also provided against certain seed-rotting and seedling-blight fungi in the soil. Seed treatments give maximum insurance benefits when cold, wet weather follows planting.

Commercial seed treating is done by special machines using a slurry, mist-type liquid or ready-mix liquid disinfestant.

Garden seed can be treated inside the seed packet or in larger quantities by using Mason jars or a rotating drum.

To treat in the seed packet, place a small mound of the treatment chemical on the tip ($\frac{1}{4}$ inch) of a small pocket knife (or broad end of a toothpick); dump into the seed packet, fold the top tightly shut, and shake thoroughly for a minute or two. Excess seed protectant may be sifted out before planting.

For larger amounts, fill a Mason jar $\frac{1}{2}$ full of seed or less, add $\frac{1}{2}$ to 1 teaspoonful of seed treatment chemical, screw the lid on tightly, and roll the jar on the floor for 5 minutes until the seed is evenly coated.

Precautions

Remember that 1 to 2 ounces of seed protectant (treatments 3-7) are enough to treat a whole *bushel* of seed. Don't overdose.

All seed treatment chemicals are toxic or poisonous. Carefully mark treated seed and do not use it for feed or food. Make sure containers which have been used for treated seed are thoroughly cleaned before reusing.

Avoid inhaling dusts or fumes when treating. Treat outdoors or in a well-ventilated room.

Follow the manufacturer's directions when handling or using seed treatment materials.

* Also included are treatments for bulbs, corms, tubers, rhizomes, roots, and other propagative plant parts, to control disease-producing organisms.

Types of Treatments

Seed treatments are of two general types: (1) *eradicative* seed treatment which destroys disease-causing fungi and bacteria carried on and within the seed, and (2) *protective* seed treatment which applies a coating to the surface of the seed thus protecting against seed rot and damping-off caused by soil organisms. Both types of treatment are important in producing disease-free vegetable and flower plants. Since seed-treating materials do not serve both as eradicants and as protectants, it is usually advisable to follow the eradicator treatment with a protective treatment.

A. Eradicative Treatments

Treatment 1 — Mercuric chloride (also called corrosive sublimate or bichloride of mercury) soak. Very poisonous. Your pharmacist may require that a "poison register" be signed before he will sell the chemical. It is an effective treatment for certain diseases of broccoli, cabbage, cauliflower, cucumber, muskmelon (cantaloup), pepper, pumpkin, squash, sweet-potato, watermelon, amaryllis, calla, canna, China-aster, gladiolus, iris, snow-flake, and sweetpea. May also be used as a general disinfectant and soil drench. Sold either as a white powder or as blue tablets. Commonly prepared to make a 1 in 1:1,000 solution by dissolving 1 ounce of mercuric chloride in $7\frac{1}{2}$ gallons of water or one 7.3 or 8 grain tablet in a pint of water. Use a wood, glass, enamel, or earthenware container as mercury eats away at metals. Dissolve the mercury in a small amount of hot water and add it to the cold water to bring to the specified volume. Use at least a quart of solution for each 4 ounces of seed.

For cucumber, melons, pumpkin, and squash place the seed in a loose-mesh cotton bag — not over $\frac{1}{2}$ full — and suspend it in a warm (60° to 80° F.) 1:1,000 solution of mercuric chloride for 5 minutes. Remove and rinse in running water for 5 minutes. Then dry and dust with treatment 3, 4, 5, or 7.

Presoak *sweetpea* seed 1 minute in alcohol followed by a 20-minute soak in a 1:1,000 solution. Then dry and dust with treatment 3, 4, 5, or 7.

For *pepper* seed soak 5 minutes in a 1:1,500 solution; 1 tablet in $1\frac{1}{2}$ pints of

water. Wash 15 minutes in running water, dry, and apply treatment 3 or 4.

Soak dormant *canna* tubers (rootstocks) or *amaryllis* bulbs for 2 hours in a 1:1,000 solution; soak dormant *calla* corms or rhizomes for 30 to 60 minutes, then wash with running water and plant. Soak *snowflake* bulbs or *China-aster* seed in a 1:1,000 solution for 30 minutes. Wash thoroughly for 5 minutes in running water, dry, and dust with treatment 3, 4, or 5. For *iris* bulbs and rhizomes soak only 10 minutes.

Soak bedding roots of *horseradish* for 20 minutes in a 1:1,000 solution. For *sweetpotato* the dipping time is 8 to 10 minutes.

Soak *gladiolus* corms 2 hours in a 1:1,000 solution just before planting.

Do not use the mercury solution more than 3 times. Make sure all washed seed is dried thoroughly before storing or planting.

To protect against damping-off and seed rot, treat seed with a protective treatment (see below and Table 13) before planting.

Treatment 2 — Hot water soak for many types of vegetable and flower seed, bulbs, corms, rhizomes, tubers, and other propagative parts. This treatment, properly applied just before planting, kills most internal and external disease-causing organisms. Also useful for disinfecting cuttings, bare-root nursery stock, and certain potted plants of nematodes.

An accurate thermometer is essential. Stir the water slowly but constantly during treatment. Hot or cold water may be added to adjust the temperature.

After treating, cool and dry the seed in a thin layer. Then apply a protective fungicide treatment (see below and Table 13) to control seed rot, damping-off, and other diseases.

HOT WATER TREATMENT TIMES (IN MINUTES) FOR SEED AND OTHER PLANT PARTS

VEGETABLE	Plant Part	Temperature of Water Bath in Degrees Fahrenheit								
		110—111	112—113	115—116	118	120	122	125	127	130—131
Broccoli (seed).....								20		
Brussels sprouts (seed).....								25		
Cabbage (seed).....								25		
Carrot (seed).....							15—20			
Cauliflower (seed).....							20			
Celery, Celery (seed).....				30						
Collards (seed).....							20			
Cress (seed).....							15			
Eggplant (seed).....							25			
Garlic (cloves).....	180									
Horseradish (roots).....	10—15									
Kale, Kohlrabi (seed).....							20			
Mint (roots).....	10									
Mustard, Radish (seed).....							15			
Rape, Rutabaga (seed).....							20			
Shallot (cloves).....			60					25		
Spinach (seed).....								25		
Sweetpotato (roots).....			65							
Tomato (seed).....							25			
Turnip (seed).....							20			

HOT WATER TREATMENT TIMES (IN MINUTES) FOR SEED AND OTHER PLANT PARTS (Cont.)

FLOWER	Plant Part	Temperature of Water Bath in Degrees Fahrenheit									
		110-111	112-113	115-116	118	120	122	125	127	130-131	135
African-violet (potted plants)	30										
Aloe (plants)			20-40	5	2	1					
Begonia (potted plants)											
Bird-of-paradise (seed)											30
Caladium (tubers)							30				
California-poppy (seed)								30			
Calla (rhizomes)							60				
Chinese Evergreen							10				
Chrysanthemum (dormant plants)	30			15							
Delphinium (seed)						40-60					10
Dieffenbachia (hardened canes)											15
Ferns (potted plants)	10-15										
Foxglove (seed)											
Gladiolus corms (dormant cormels)	240										30
Glory-of-the-snow (dormant bulbs)	180										
Hyacinth (dormant bulbs)	180										
Iris (dormant bulbs)	180										
Lily (dormant bulbs)	60										
Narcissus (dormant bulbs)	180-240										
Nasturtium, garden									25		
Nephthytis (bare-root)						30					
Orchid (<i>Vanda</i>) (cuttings)			10								
Pansy, Violet (potted plants)	30										
Peony (dormant roots)						30					
Philodendron (canes)						30					
Sansevieria (bare-root)								10			
Silver threads (plants)								30			
Snowdrop (dormant bulbs)	180										
Scilla, Squill (dormant bulbs)	180										10
Stock (seed)											
Tuberose (tubers, offsets or "seed")						60					
Tulip (dormant bulbs)	180								30		
Zinnia (seed)											
FRUIT, SHRUB, TREE											
Avocado (seed)							30				
Boxwood (cuttings)		25			30						
Citrus (bare-root)							10				
Gooseberry (cuttings)	30										
Grape (rootings)							10	5	3		
Locust, black (dormant trees)					30						
Strawberry (dormant plants)								2-3	1		

Dormant, properly cured bulbs of dafodil, glory-of-the-snow, garlic, hyacinth, iris, lily, narcissus, snowdrop, scilla or squill, and tulip should be soaked in hot water and formaldehyde (1 part of 37-40 per cent commercial formalin in 200 parts of water) to control root- and bulb-rotting fungi, nematodes, bulb mites, and other pests.

B. Protective Treatments

Treatment 3—Thiram 75 per cent. Used for protecting most vegetable, flower, grass, tree, and shrub seed against seed rot, seedling blights (damping-off), and surface-borne smuts. Also used as a flower bulb dust and drench in flats or seedbeds for controlling seed rot and damping-off. Kills surface-borne organisms.

Thiram 75 per cent is sold as Arasan 75, SF-X, SF-M; Panoram 75; Thiram 75W, and SF-75. It is mostly used at $\frac{1}{2}$ to $\frac{2}{3}$ teaspoonful per pound of seed but check package labels for precise directions. Often combined with an insecticide, e.g., dieldrin and sold as Delsan A-D Seed Protectant and Panoram D-31. These fungicide-insecticide combinations have proved definitely superior on bean, corn, cucumber, and pea seed.

Treatment 4—Captan 75 per cent. Same uses and rates as for treatment 3, but check package labels. It is sold as Captan 75 Seed Protectant, Orthocide Seed Protectant, Orthocide 75, and Captan 75. Often sold combined with an insecticide, e.g., dieldrin: Captan-Dieldrin 60-15 Seed Protectant and Orthocide-Dieldrin 60-15 Seed Protectant. These combinations, like treatment 3, have proved definitely superior on bean, corn, cucumber, and pea seed.

Treatment 5—Chloranil. It has the same uses as treatments 3 and 4. Sold as Spergon, Spergon-SL Seed Protectant, and Niagara Seed Protectant. Check trade labels for precise directions.

Treatment 6—Dichlone. This is used for treating various vegetables and flowers to control seed rot and seedling blights. It is sold as Phygon Seed Protectant, Phygon-XL, and Phygon Naugets.

Treatment 7—Semesan. A mercury-containing treatment for many vegetable and flower seed, also a soak treatment for flower bulbs, corms, roots, tubers, and cacti. Semesan Bel is used as a dip for sweetpotato roots and white (Irish) potato seed tubers.

TABLE 13

SEED TREATMENT METHODS AND MATERIALS FOR VEGETABLES, FLOWERS, TREES, AND SHRUBS *

Crop	Diseases	Treatment Number	Method of Treatment †	Time and Remarks
Vegetables				
Asparagus	Damping-off	Calogreen 4 ozs. or Ceresan M $\frac{1}{3}$ oz. per lb. of seed	D	Just before planting
Beans	Seed rot, damping-off, stem blights, root rots	3, 4, 5	D or S	Any time
Beet, Swiss Chard, Mangold	Seed rot, damping-off, leaf spot	3, 4, 6	D	Any time. See Beet
Cabbage, Cauliflower, Brussels Sprouts, Broccoli, Collards, Kale, Kohlrabi, Radish, Mustard, Turnip, Cress, Rape, Rutabaga	Seed rot, damping-off, blackleg, black rot, downy mildew, leaf spot, scab, yellows	2 then 3, 4, 5, 7	Dip then D	Just before planting. See Cabbage
Carrot	Seed rot, damping-off	3, 4, 5, 6	D or S	Any time
	Bacterial blight	2 then 3, 4, 5, 6	Dip then D or S	Just before planting
	Storage rots	3, 4	D	Before storage
Celery, Celeriac	Leaf blights, seed rot, damping-off	2 then 3, 4, 5, 7	Dip 30 min. then D or S	Just before planting
Corn (Broom, Ornamental, Pop, Sweet)	Seed rot, seedling blights, root rots, leaf spots, and blights	3, 4, 5, 6	D or S	Any time
Anise, Caraway, Chicory, Dill, Endive, Escarole, Fennel, Parsley, Salsify	Seed rot, damping-off	3, 7	D or S	Any time
Cucumber, Melons, Pumpkin, Squash, Chayote, Gherkin, Gourds	Seed rot, damping-off, black rot, angular leaf spot, anthracnose, Fusarium wilt	1 then 3, 4, 5, 7	Dip 5 min. then D or S	Just before planting
Horseradish	White-rust	2	Dip 10 to 15 min.	Just before planting
	Bacterial soft rot	1	Dip 20 min.	See Cabbage
Lettuce	Seed rot, damping-off, leaf spots, and blights	3, 4, 5, 7	D or S	Any time
Okra	Seed rot, damping-off	3, 4, 5, 6	D or S	Any time

* Follow manufacturer's directions regarding rate, precautions, and other factors.

† Treatment method: D — dust; S — slurry; Dip — soak or dip; P — pelleting.

TABLE 13 (*Cont.*)

SEED TREATMENT METHODS AND MATERIALS FOR VEGETABLES, FLOWERS, TREES, AND SHRUBS *

Crop	Diseases	Treatment Number	Method of Treatment †	Time and Remarks
Vegetables				
Onion, Chives, Garlic, Leek, Shallot	Seed rot, damping-off, smut, purple blotch	3, 4	D or P	See Onion
	Nematodes	2	Dip 1 to 3 hours	See Onion
Parsnip	Seed rot, damping-off	3, 7	D or S	Any time
Pea	Seed rot, root rots, damping-off, <i>Ascochyta</i> and <i>Mycosphaerella</i> blights, <i>Fusarium wilts</i> , bacterial blights	3, 4, 6, 7	D or S	Any time
Peanut	Seed rot, seedling blights	3, 5	D or S	Any time
Potato, Irish	Seed-piece decays	3, 4, 5, 6, 7, manebe, zincb	D or Dip	Treat cut seed
	Blackleg	streptomycin 200 parts per million	Dip	Treat cut seed
Shallot	Bulb nematode	2	Dip 1 hour	Just before planting
	Bulb rots	Dowicide B	Dip 15 min.	See Onion
Spinach	Anthracnose, seed rot, damping-off	3, 4, 5, 6, 7	D or S	Any time
	Downy mildew, leaf spot	2 then 3, 4, 5, 6, 7	Dip 25 min. then D	Just before planting
Sweetpotato	Black rot, scurf, seed decay	1, 6, 7	Dip	See Sweet-potato
	Root-knot	2	Dip 65 min.	See Sweet-potato
Tomato, Eggplant, Pepper	Bacterial spot, canker and speck, seed rot, damping-off, anthracnose, Cerco-spora and <i>Septoria</i> leaf spots, <i>Phytophthora</i> blight, early blight, <i>Phomopsis</i> blight	1, 2 then 3, 4	Dip then D or S	Just before planting. See Tomato

* Follow manufacturer's directions regarding rate, precautions, and other factors.

† Treatment method: D — dust; S — slurry; Dip — soak or dip; P — pelleting.

TABLE 13 (*Cont.*)

SEED TREATMENT METHODS AND MATERIALS FOR VEGETABLES, FLOWERS, TREES, AND SHRUBS *

Crop	Diseases	Treatment Number	Method of Treatment †	Time and Remarks
Flowers				
Most flowers both annuals and perennials	Seed rot, certain leaf spots	3, 4, 5, 7	D or S	Any time
	Damping-off, cutting rots	3, 4, 7, Terraclor and 4	Soil drench 1 tbsp. each per gallon	Apply 1 pint per square foot
African-violet	Leaf nematode	2	Dip 30 min.	Potted plants
Aloe	Root rot	2	Dip 20 to 40 min.	Just before planting
Amaryllis	Bulb rots, leaf scorch	1	Dip 2 hrs.	Just before planting
Aster, China-	Leaf spots, Fusarium wilt, seed rot, damping-off, stem rot	1, 7 then 3, 4	Dip 30 min. then D	Just before planting
Begonia	Leaf nematode	2	Dip	Potted plants
Bird-of-paradise-flower	Root and seed rots	2	Dip 30 min.	Just before planting
Cacti	Slimy collar rot	7	Dip 5 min.	Just before planting
Caladium	Tuber rot, root-knot	2	Dip 30 min.	Just before planting
California-poppy	Stem and root rots, Heterosporium spot	2	Dip 30 min.	Just before planting
Calla	Bacterial soft rot, root rot	1, 2	Dip 30 to 60 min.	See Calla
Canna	Bacterial bud rot	1	Dip 2 hrs.	See Canna
Chinese Evergreen	Root-knot	2	Dip 10 min.	See Calla
Chrysanthemum	Leaf nematode	2	Dip 15 to 30 min.	See Chrysanthemum
Delphinium	Bacterial stem rot	2	Dip 10 min.	See Delphinium
Dieffenbachia (hardened canes)	Root and stem rots	2	Dip 40 to 60 min.	See Calla
Ferns	Leaf nematode	2	Dip 10 to 15 min.	Potted plants
Foxglove	Anthracnose	2 then 3, 4, 5	Dip 15 min. then D	Just before planting

* Follow manufacturer's directions regarding rate, precautions, and other factors.

† Treatment method: D — dust; S — slurry; Dip — soak or dip; P — pelleting.

TABLE 13 (Cont.)
SEED TREATMENT METHODS AND MATERIALS FOR VEGETABLES, FLOWERS, TREES, AND SHRUBS*

Crop	Diseases	Treatment Number	Method of Treatment†	Time and Remarks
Gladiolus	Corm rots, yellows, neck rot, bacterial leaf blight, scab, leaf and flower spots	1, 2, 3, Emmi, Ceresan dip	D or Dip	See Gladiolus
	Nematodes, smut	2 plus formalin 1:200	Dip 4 hrs.	See Gladiolus
Hollyhock, Hibiscus, Lavatera, Mallow	Seed rot, damping-off	3, 4, 5, 6	D or S	See Hollyhock
Iris	Crown rots, bacterial soft rot, rhizome and bulb rots	1, 7, phenyl mercury	Dip 10 min.	See Iris
	Storage rots or molds	3, 5	D	Before storage
	Bulb, root, and stem nematodes, ink disease	2 plus formalin 1:200	Dip 3 hrs.	See Iris
Lily	Nematodes	2 plus formalin 1:200	Dip 1 hr. then 5	See Lily
	Bulb and crown rots	Terraclor plus 4 or ferbam	Dip 30 min.	See Lily
Mint	Rust	2	Dip 10 min.	See Salvia
Narcissus, Daffodil, Snowdrop	Bulb rots, root rots, neck rot, Botrytis blight	Ceresan, Emmi, Pur- atized, Mersolite 8, Dow- cide B	Dip follow- ing manu- facturer's directions	Just before planting. See Daffodil
	Stem, bulb, and root nematodes, browning disease, bulb rots, root rots	2 plus formalin 1:200	Dip 3 to 4 hours	See Daffodil
Nasturtium, garden	Heterosporium leaf spot	2	Dip	Just before planting
Nephthytis	Root rot	2	Dip 30 min.	See Calla
Orchid, Vanda	Leaf and bud nematode	2	Dip 15 min.	See Orchids
Orchids	Seed rot, seedling blight, mold	chlorine	Dip	See Orchids
	Leaf blight, black rot, stem and root rots, bacterial soft rot	Bioquin 1, Natriphene	Dip	See Orchids
Pansy, Violet	Anthracnose, scab, wilt, damping-off, smuts	3, 4, 5, 6, 7	Dip or S	Any time

* Follow manufacturer's directions regarding rate, precautions, and other factors.

† Treatment method: D — dust; S — slurry; Dip — soak or dip; P — pelleting.

TABLE 13 (Cont.)

SEED TREATMENT METHODS AND MATERIALS FOR VEGETABLES, FLOWERS, TREES, AND SHRUBS*

Crop	Diseases	Treatment Number	Method of Treatment†	Time and Remarks
Pansy, Violet (Cont.)	Leaf and bud nematodes	2	Dip 30 min.	See Pansy
Peony	Root-knot	2	Dip 30 min.	See Delphinium
Philodendron	Bacterial stem rot, cane rots, root-knot	2	Dip 10 to 30 min.	See Calla
Rose	Botrytis storage decay	4, Terraclor	Dip or D	See Rose
Safflower	Rust	Panogen 15, Ceresan, Acti-dione, 6	Dip or D	See Chrysanthemum
Sansevieria	Root-knot	2	Dip 10 min.	See Sansevieria
Silver Threads	Stem and root rot	2	Dip 30 min.	See Silver Threads
Snapdragon	Seed rot, damping-off	7	D or S	Any time
Snowflake	Gray-mold blight	1	Dip 30 min.	Just before planting
Stock	Bacterial blight	2 then 7	Dip 10 min.	See Cabbage
Sweetpea	Anthracnose, wilt, seed rot, damping-off, streak, fasciation	1 then 3, 4, 6, 7	Dip 20 min. then D	Pre-dip 1 min. in alcohol
Tulip, Glory-of-the-snow, Grape-hyacinth, Hyacinth, Scilla, Snowdrop	Bulb and root rots	3, 4, 5, zineb	D	See Tulip
	Nematodes	2 plus formalin 1:200	Dip 3 hours	See Tulip
Zinnia	Blight	2 then 3, 4, 5	Dip 30 min.	Just before planting
Trees, Fruits, Shrubs, and Vines				
Practically all	Seed rot	3, 4, 6	D or S	Any time
	Damping-off	3, 4, 7, ferbam, maneb	Soil drench	1 pint per square foot
Avocado	Root rots	2	Dip 30 min.	Just before planting
Boxwood	Root-knot	2	Dip 30 min.	See Boxwood

* Follow manufacturer's directions regarding rate, precautions, and other factors.

† Treatment method: D — dust; S — slurry; Dip — soak or dip; P — pelleting.

TABLE 13 (*Cont.*)

SEED TREATMENT METHODS AND MATERIALS FOR VEGETABLES, FLOWERS, TREES, AND SHRUBS*

Crop	Diseases	Treatment Number	Method of Treatment †	Time and Remarks
Citrus	Root rot, nematodes	2	Dip 10 min.	See Citrus
Gooseberry	Bud nematode	2	Dip 30 min.	See Currant
Grape	Nematodes	2	Dip 3 to 10 min.	See Grape
Locust, black	Root-knot	2	Dip 30 min.	See Honey-locust
Strawberry	Nematodes	2	Dip 1 to $7\frac{1}{2}$ min.	See Strawberry
	Black root rot, leaf spots	zineb	Dip or drench	See Strawberry
Lawngrasses	Seed rot, seedling blights	3, 4	D or S	See Lawngrasses

* Follow manufacturer's directions regarding rate, precautions, and other factors.

† Treatment method: D — dust; S — slurry; Dip — soak or dip; P — pelleting.

SOIL TREATMENT METHODS AND MATERIALS

The purpose of soil treatment is to kill or control disease-inducing organisms (bacteria and fungi), nematodes, insects, and weed seeds in the soil.

Soil can be sterilized (better called pasteurized) or fumigated easily using either heat or chemicals. Heat is generally the most effective since it kills all types of pests. Many chemicals are quite selective and will kill only nematodes or fungi at normal rates of application.

In recent years a number of chemicals have been formulated as liquids to be applied in the soil. Most of these chemicals become gases and diffuse in the soil to effect the kill.

Sterilization or fumigation should be an important part of your sanitation program. It will aid you in growing healthy, vigorous plants.

Precautions

1. The soil must be easily crumbled (friable) so that heat or chemicals can penetrate throughout. All clods and old plant debris, especially large diseased roots, should be broken up or decomposed. Soil should be in good planting condition when treated.

2. The soil must not be too wet. It should have sufficient moisture for good germination or so it will just hold its shape when squeezed in the hand.

3. The soil temperature 4 to 6 inches deep should be 60° to 65° F. or preferably between 70° and 80° F. to permit effective gas dispersion (for chemical treatment only).

4. All amendments (e.g., manure; peat, other humus material, compost, sand) must be added before treating.

5. Treat tools (hoes, rakes, spading forks), clay pots, and flats by laying them on top of the soil and under the cover. Otherwise, dip them in a 1:20 formaldehyde solution after each use in contaminated soil and before using in treated soil. Boards or concrete at the edges of the bed should also be treated.

6. Do not transplant seedlings or other plants from untreated or contaminated soil into disinfested soil. Sterilized soil is easily recontaminated by using any one of the following: nonsterilized flats or pots; tools containing small bits of nonsterilized soil; a contaminated source of

water; spattering by a poorly aimed stream of water; parasites in and on seed or other plant material, or gardener's hands and feet; and the use of unsterilized compost or manure.

7. After treating let the soil air before seeding or planting. After steaming wait a day or two. After using chemicals wait 2 to 4 weeks. Soils high in organic matter or clay, excessively wet, or treated at low temperatures may retain toxic properties even longer. *Follow the manufacturer's directions on the label.* A week after treating with chemicals, work the soil at least once to a depth of several inches to allow gas to escape.

8. If steaming large quantities of soil, use a pressure between 15 and 100 pounds.

9. Don't oversterilize with steam by letting temperatures build up much over 180° to 200° F. or by leaving the steam on too long. Be sure to use an accurate thermometer. Do not guess. The soil should be held at the coolest spot to 180° F. for 30 minutes, or turn off the steam when the temperature first reaches 200° F.

10. Chemical soil fumigants are often irritating to the membranes of the mouth, eyes, nose, and throat. Exercise all necessary precautions when using fumigants. Avoid spilling any of the liquid chemicals on the skin, clothing, or shoes. If this should happen, wash it off the skin promptly with generous amounts of soap and water. Remove affected clothing or shoes at once and air for several weeks. These materials are also corrosive to metals. Applicators should be rinsed with kerosene after use.

11. Fall is the ideal time for chemical treating of soil; crops have been harvested and temperatures are still moderate.

Treatments Using Heat

There are many ways in which heat can be used to pasteurize soil. Some methods (1-3) are suitable for treating a few flower pots or flats. Others are probably used only by commercial growers (4-9).

1. *Oven Sterilization* — Suitable for disinfecting small amounts of soil. Place the soil in a small greenhouse flat, deep baking pan, or roaster (aluminum, glass, or iron). The soil should be level and not over 4 inches deep. Bury a small potato, about 1½ inches in diameter, in the center. Then cover the container with

heavy aluminum foil and seal down the edges. Punch a small hole through the center of the foil and insert the bulb-end of a meat or candy thermometer into the center of the soil. Place in a low-heat oven held at about 180° to 200° F. Keep the soil in the oven 30 minutes after the temperature reaches 180° F. Then remove and let cool. The potato should be well-cooked. *Avoid oven temperatures above 200° F.* which might burn organic matter in the soil and destroy soil structure.

2. *Pressure Cooker With Pressure* — Use a home-canning-type pressure cooker. Put several cups of water in the bottom of the cooker. Place the soil in shallow pans (no more than 3 or 4 inches deep). Level the soil but do not tamp or firm. Stack the pans on the rack inside the cooker, separating each pan with clothespins or lath strips for free circulation of steam. Close the lid, but don't tighten the steam valve completely until all air is forced out and live steam is escaping. When the pressure has reached 10 pounds, run at this level for 15 minutes. Then turn off the heat. Remove the pans of soil when cool.

3. *Pressure Cooker Without Pressure* — Pour about a gallon of water into the pressure cooker, laundry boiler, or large kettle. Use a rack to hold the soil pans up out of the water. Put in shallow pans of soil (see 2 above) and clamp on the lid. Leave the steam valve slightly open. Apply sufficient heat to keep the water boiling. Open the valve or lid just enough so that it holds in steam but prevents much pressure from building up. When live steam begins to be forced out, continue to apply heat for another 30 minutes. Keep the cooker closed and do not remove the soil until it is cold.

4. *Underground Tile Method* — Use 3- or 4-inch cement or agricultural drain tile laid in parallel rows 12 to 20 inches apart and at a depth of 10 to 15 inches in the soil. The distance and depth depend principally on the nature of the soil and depth of cultivation. Pipes from the steam boiler are connected to the tile lines. Broken stone placed on each joint aids the steam in penetrating the soil. The opposite ends of each string of tiles should be left open until steam circulates freely. These openings should then be closed.

The temperature of the soil farthest

removed from the steam inlet (or the coldest spot) should be kept at 180° F. for at least 30 minutes (160° F. for an hour or longer). A longer time is better for heavy soils. Determine the temperature by inserting thermometers into the soil at different places and at various depths.

In ground beds, it is usually sufficient to raise the temperature at the soil surface to 180° F. if the soil is well loosened before steaming.

Pasteurization may be considered complete when a medium-sized potato buried about 3 inches deep in the soil, is well-cooked after steaming. Heat is retained longer by covering the soil with plastic, canvas, sisalkraft paper, sacks, boards, or straw mats.

A steam boiler is needed to make steam under pressure. A 50 horsepower boiler will steam about 500 square feet of bed satisfactorily to a depth of 16 to 22 inches in 4 to 8 hours. In 1 or 2 hours, sterilization can be effected to a depth of 9 to 18 inches.

The heating pipes in the greenhouse may be used for carrying steam from the boiler to the buried tile drains. A short branch pipe extension from a joint over each string of tiles extends down into the soil to the level of the tile, and then turns at right angles. The pipe should reach several feet into the drain. Valves should be placed in the conducting pipe so that a combination of drains can be treated at once, depending on the capacity of the boiler.

5. *Tank or Vault Steaming* — Flats full of soil can be run into a large tank or vault and sealed in. The tank is then filled with steam to a pressure of several pounds and held for an hour or longer. Flats should be placed in racks or at least be separated by blocks of wood. This allows free circulation of the steam.

6. *Underground Pipe Method* — Especially adapted to raised benches, although this method may be used in ground beds. Use 1½- to 2-inch piping bored with $\frac{3}{16}$ - to $\frac{1}{4}$ -inch holes about 6 to 12 inches apart.

In benches, lay piping about 1 inch from the bottom (6 to 8 inches deep) and 12 to 14 inches apart with the perforations on the underside. If placed in ground beds, the piping should be about 15 inches deep and about 18 inches apart.

Install piping as a permanent fixture or remove after each treatment to avoid deterioration. For easy removal, fasten wires at 10- to 15-foot intervals when the lines are being laid. Extend the wires far enough above the soil surface so you can easily grasp them. For steaming, see 4 above.

7. Aboveground Pipe Method — Lay 4- to 10-foot sections of galvanized metal downspouting on top of the soil. Leave 1-inch spacings between sections. Lead steam directly from the boiler line into the pipe. Drill small holes alternately on opposite sides of the downspouting. The only way to determine the exact size and spacing of holes is by trial. As a rule, the nearer the holes are to the steam inlet, the larger or closer together they must be. In some installations the holes are $\frac{1}{4}$ inch in diameter, from 18 to 24 inches apart near the steam inlet, and as much as 36 inches apart at the opposite end.

Usually it is best to treat no more than 100 linear feet of bench or bed space at a time. If the bed is long, lead the steam into a T-coupling at the center of the bed, just above the soil surface.

When the pipes are laid in position, 12 to 15 inches apart, on top of the soil, cover the soil and pipes with a plastic (polyethylene or vinyl) cover, plastic-impregnated fabric, or sisalkraft paper and tack or weight it along the margins to keep the steam in. Use the same temperature and timing as for other steam-sterilizing methods (see 4 above).

8. Inverted Pan Method — Especially suitable for treating soil in shallow benches and flats. May also be used on small ground beds if the soil is well loosened before treatment. The reinforced steel, 16- or 18-gauge galvanized iron or wooden pan may be any desired shape to fit over your bench or ground area. It should not be more than 70 to 75 square feet in area; but at least 8 inches deep. Before steaming press the pan firmly into position. You may have to weight the pan down with stones or sandbags to hold it in place.

A flexible 1-inch hose connects the pan to the steam line. The hose fitting and intake should preferably be at the end of the pan. Use the same temperature and timing as for other steam-sterilizing methods (see 4 above). Usually a time of $\frac{1}{2}$

to $1\frac{1}{2}$ hours, at a steam pressure of 80 to 100 lbs., is sufficient.

9. Flash-Flame Pasteurizers — Popular with commercial growers. The equipment — a heated cylinder 8 feet long and 20 inches in diameter — is adapted from a tar-melting machine used in road construction. A kerosene-burning torch throws a flame into the lower end of the slightly sloping cylinder. The cylinder is turned about 40 times per minute by means of a $1\frac{1}{2}$ horsepower engine (gasoline or electric). Soil is shoveled into the upper end of the cylinder just fast enough so that its temperature is 175° to 190° F. when it drops out pasteurized at the lower end.

Treatments Using Chemicals

10. Formaldehyde — Cheap, easy to use, and fairly satisfactory. Sometimes known as formalin. Contains 37 to 40 per cent commercial formaldehyde in water. Can be purchased at most drugstores. Effective against most fungi and bacteria, insects, and soft or germinating weed seed. Ineffective against nematodes.

Three tablespoons of formaldehyde, diluted with 4 to 6 times that much water, are sufficient for 1 bushel of soil (32 quarts). Use somewhat heavier dosages for very heavy or peat soils. One tablespoon of undiluted formaldehyde in $\frac{1}{2}$ cup of water treats a florist's flat of soil.

Sprinkle the diluted formaldehyde on the soil and mix it in thoroughly with a shovel or hoe. Mixing may be done on the floor, on a bench, or some other convenient flat surface. Treated soil is then put into the seed flats, pots, a box or can, or left in a compact pile. Cover tightly with a piece of plastic, wet burlap, newspapers, or canvas to hold in all fumes for at least 48 hours.

Since the fumes are toxic, *keep well away from plants and animals*. Never use in a greenhouse where plants are growing!

Remove the cover and air the soil by working it occasionally. Be sure all fumes are gone before seeding or planting in it.

Soil in a cold frame, seed flat, or unplanted flower bed can be treated with a formaldehyde drench. Mix 1 gallon of formaldehyde in 49 gallons of water (1 cup in 3 gallons) and apply $\frac{1}{2}$ to $1\frac{1}{2}$ gallons to each square foot of soil which

has been spaded and pulverized. Use a sprinkling can. Then cover the soil with canvas, boards, plastic, or sisalkraft paper. After 48 hours remove the cover and allow the formaldehyde fumes to escape. Let the soil air out for a week or two. Working the soil with a hoe will help the fumes escape. Do not plant until all formaldehyde odor is gone (usually 10 to 14 days).

Do not plant the seed of stock or other members of the cabbage family in formalin-treated soil.

Home Garden Nematode Control

Buy EDB or D-D Soil Fumigant and make the application from a quart Mason jar with 2 nail holes punched in the lid. With a hoe, make furrows 6 to 8 inches deep and 10 to 12 inches apart across the garden. Walk along the furrow dribbling the undiluted fumigant in the bottom of the furrow. Use about 1 cup of D-D Soil Fumigant or $\frac{1}{2}$ cup of EDB-40 ($\frac{1}{4}$ cup of EDB-85) for each 75 feet of row. After application of no more than 100 feet, stop, rake over, and cover the furrow. Tamp the soil to seal the gas in the soil. Continue the 10- to 12-inch spacing across the garden. Wait at least 2 weeks before planting. If the soil temperature during the waiting period is below 60° F., or if the rainfall has been heavy, wait 3 or 4 weeks.

Applying Volatile Disinfectants (Fumigants)

A number of volatile chemicals are available for treating the soil to control nematodes, fungi, bacteria, and weed seeds (treatments 14 to 25 in Table 14).

Excellent literature on calibration of equipment is available from fumigant suppliers.

Numerous types of application equipment have been devised:

(1) *A hand applicator* is suitable for treating small areas. It consists of a container for the fumigant, a long, hollow, pointed base for penetrating the soil, and a plunger or trip. When the plunger is pressed, an exact amount of fumigant is placed into each location. Several models are available which can be accurately calibrated to deliver the dosage recommended by the manufacturer.

Before treating, the soil surface is marked off into 10- to 12-inch squares. Application is in a diamond pattern by making injections at the junctions of the cross on the first row and halfway between on the second row, at the junctions in the third row, halfway between in the fourth row, and so on across the garden.

(2) *Plow-furrow equipment* may be purchased from several companies. The machinery is mounted on a plow. A control block, mounted on the steering post of the tractor, regulates the delivery rate which varies with the tractor speed. The fumigant outlet (spray nozzle) is in front of each plowshare. The chemical should be covered by soil from the moldboard, to a depth of 5 to 10 inches, as soon as applied. A chain harrow should be dragged behind to close soil openings and level ridges.

(3) *Tractor-mounted shank applicators* are widely used by commercial growers. The liquid fumigant enters the soil through tubes attached to the rear of a staggered row of cultivator shanks, spaced about 10 inches apart. The chemical is placed in the bottom of the furrow (usually 5 to 10 inches deep) made by the shank as it is pulled through the soil. These machines must be carefully calibrated to deliver the recommended dosage uniformly. A chain harrow or heavy drag pulled behind seals the furrows. The soil should be plowed and worked thoroughly before fumigant is applied.

(4) *Application in 8-inch ridges* using Vapam or V.P.M. Soil Fumigant is a convenient method in certain areas where the soil is loose and sandy. The fumigant is dropped from an applicator mounted just in front of the ridging disc wheels. The ridges are then rolled flat except for a shallow, 2-inch furrow in which crops are planted 2 weeks or more later when the chemical fumes have escaped. Fifty pounds or more of the chemical is applied per acre in rows 30 to 42 inches apart. Check with the manufacturer, your chemical dealer, or your extension plant pathologist regarding recommended rates.

(5) *Steel drums or tight garbage cans* are convenient for treating small amounts of soil.

(6) *Aerosol bombs* are available for certain chemicals for fumigating soil under

gas-tight coverings. Follow the manufacturer's directions carefully.

(7) *Methyl bromide*. This treatment is only recommended for commercial growers who are properly equipped. A gas mask must be worn when the cover is removed. *Methyl bromide is an extremely poisonous, odorless gas.* All necessary precautions must be followed to the letter! The chemical is available in 1-pound cans or in steel cylinders of various sizes. The treatment can be made under *gas-proof* covers (e.g., polyethylene or vinyl plastic), in metal-lined vaults, or steel drums. Canvas should not be used. The soil, containers, tools or machinery to be disinfested are placed on a concrete floor or a *gas-proof* material as a base. Everything should be covered carefully, leaving no place for possible leaks. The edges of the cover are weighted down or buried. Leave room under the top so that the gas can circulate freely. Place the end of the plastic or copper tube from the methyl bromide container under the cover, with the end passing into open trays where the methyl bromide is evaporated.

Before treating, the cubic footage of the space must be calculated accurately. Use the fumigant at the rate of 10 to 40 pounds for each 1,000 cubic feet. The

cover is left in place for 48 hours if the weather is cool. Twenty-four hours is sufficient in hot weather. Plant after several days.

(8) *In-row, shank-injector method*—An economical treatment suggested for certain row crops growing on light sandy soils. One-third the normal broadcast dosage of fumigant (see 3 above) is injected into the row. The soil is then thrown by sweeps into a ridge over the fumigant. Spaces between ridges are usually 36 or 42 inches for sweetpotatoes, and 4-6 feet for tomatoes and other vegetable crops. Provides for a treated strip 1 foot or more wide in which young plants start. Gives good protection at a lower cost per acre for fumigant. The treated strip must be carefully marked for planting 2 weeks or more later. Growers cannot cultivate using this method.

(9) *Granular application*—DBCP (Fumazone, Nemagon) or other fumigant may be made with any type of fertilizer distributor which will deliver the granular material 5 to 6 inches below the soil surface. A spacing of 10 to 12 inches is desirable. In-row treatment of wide-spaced crops is most economical and gives satisfactory control. Carefully follow the manufacturer's directions.

TABLE 14
SOIL TREATMENT METHODS AND MATERIALS

TREATMENTS		CONTROLS	APPLICATION AND REMARKS
No.	Materials, Brands		
11 —	Captan, Thiram, Zineb	See Table 1	Seed rot, damping-off, seedling blights in green- house benches, flats, pots, and hotbeds.
12 —	Semesan, Pano-drench 4	Same as 11	Apply as drench to loose, level, fairly dry soil following the manufacturer's directions. Apply with a sprinkling can. You may plant as soon as the treated soil has dried sufficiently — if the label does not say otherwise.
13 —	PCNB, Terraclor, Terracap, Orthocide Soil Treater "X"	Certain disease-causing fungi	Various application methods may be used including suspension in trans- plant water, soil surface sprays or dusts, and dry mixing in upper 4 to 6 inches of soil. Sometimes mixed with ferbam, captan, thiram, or phalan- tan.
14 —	EDB, Dowfume W- 85, W-40; Soilfume 40, 85, 60-40; Nemex 40, 85; Garden Dow- fume, Bromofume 40, 85 (1, 2-dibromo- ethane)	Nematodes, soil insects, garden centipedes	Follow the manufacturer's recom- mendations. Apply at least 4 to 8 inches deep, at 10- to 12-inch inter- vals, with special tractor-mounted equipment. Do <i>not</i> use for 3 years before planting onions. See also note on nematode control in the home garden above. Wait 2 or 3 weeks be- fore planting.
15 —	D-D Soil Fumigant, Telone, Vidden D, Nemafume, Oma-D (1,3 - dichloro pro- pane-1,2-dichloro - propane)	Nematodes, soil insects	Follow the manufacturer's recom- mendations. Apply about 6 inches under soil surface like EDB at 10- to 12-inch intervals. Do not plant until 2 to 4 weeks after treatment applica- tion. Use at a different rate on muck (peat) soil. See also note on nematode control in the home garden above.
16 —	Chloropicrin, Larva- cide 100, Picfume (tear gas or trichlo- ronitromethane)	Damping-off, seedling blights, other soil-inhab- iting disease organisms, weed seeds, nematodes, soil insects	Apply with special injection equip- ment in holes 4 to 6 inches deep in rows 10 inches apart, spaced such that the holes are 10 to 12 inches apart in the rows. In greenhouse benches or hotbeds, injections should be spaced as above but $\frac{2}{3}$ the depth of the soil. Inject 3 to 4 ml. in each hole and close by kicking soil into the hole. After treating, apply suffi- cient water to soak upper inch of soil to seal in the gas. Maintain water seal for 3 days. Do not plant in treated soil until <i>all</i> traces of chloro- picrin have disappeared. This may be from 12 days to 4 weeks. Use a chloropicrin mask and cannister while working.

TABLE 14 (Cont.)
SOIL TREATMENT METHODS AND MATERIALS

TREATMENTS No. Materials, Brands	CONTROLS	APPLICATION AND REMARKS
17 — Dorlone (mixture of Telone & EDB)	Nematodes	Same as for D-D. Use at rate of 12 gallons per acre. Do <i>not</i> use where onions will be grown within three years.
18 — Methyl Bromide, Dowfume G-40, Bro-mex, Pano-Brome, Brozone	Nematodes, soil insects, weed seeds, damping-off, seedling blights	Gas in pressure cans or cylinders. Must be applied with a special kit under a gas-tight plastic cover. For most pests use 1 pound per 100 square feet. To kill soil fungi, use 3 to 4 pounds. Needs only 7- to 10-day wait between treating and planting. Good in cold frames, greenhouses, and outdoor beds. Suggested for commercial growers <i>only!</i> Extremely poisonous.
19 — Dowfume G (methyl bromide and xylene)	Nematodes, damping-off of seedlings, seed-rotting fungi	Apply 6 to 7 ml. in holes spaced 10 inches apart with a special applicator. Soil should be soaked to a depth of 1 inch to create a water seal to hold the gas in the soil. Follow the manufacturer's directions. Very poisonous.
20 — Pano-Brome CL and S, Dowfume MC-2, Bed-Fume, Pestmaster, Kolker Methyl Bromide (methyl bromide and chloropicrin)	Nematodes, grubs, cut-worms and other soil insects, seed rot, damping-off, weed seeds	In hotbeds and greenhouses apply with a special applicator at 4 ml. spaced at 10-inch intervals. For field applications use about 400 pounds per acre when applied by continuous surface, multiple row machine. Follow the manufacturer's directions. Extremely poisonous.
21 — Vapam 4-S, V.P.M. Soil Fumigant, Chem-vape (Sodium n-methylthiocarbamate dihydrate)	Soil-inhabiting disease organisms, nematodes, many germinating weed seeds, soil insects	For clay soils use 1½ to 2 quarts per 100 square feet. For light and medium-textured soils use 1 qt. When applying, sprinkle uniformly over the soil with a sprinkling can, hose proportioner, sprayer, or irrigation system. Apply a water seal to upper 1 inch of treated soil (15 to 20 gallons per 100 square feet). Do not treat more than 100 square feet at a time before applying water seal. When top-treated soil has dried sufficiently, cultivate 1 to 2 inches deep. Do not plant until 3 weeks after treating. No cover required.
22 — Mylone 25% WP, 50% WP, 85% WP, Dust-50; Soil Fumigant M; Mico-Fume (Dimethyltetrahydro-1,3,5,2H-thiadiazine-2-thione)	Soil fungi, weed seeds, nematodes, soil insects	Follow manufacturer's directions. Usually ¾ to 2⅔ pounds per 100 square feet. Apply at least 21 days before planting. Apply as drench or granules. Disc into soil. Used as pre-planting treatment for seed and plant beds.
23 — Bedrench (81 per cent allyl alcohol and 11.5 per cent EDB)	Nematodes, weed seeds, some soil fungi	Apply like Vapam or V.P.M. Soil Fumigant. Considerable water and a 14-day waiting period are needed. Follow the manufacturer's directions. Used primarily as a seedbed drench.

TABLE 14 (*Cont.*)
SOIL TREATMENT METHODS AND MATERIALS

TREATMENTS No. Materials, Brands	CONTROLS	APPLICATION AND REMARKS
24— Nemagon, Edco Nemadrench, Fuma- zone (DBCP or 1,2- dibromo-3-chloro- propane)	Nematodes	Follow the manufacturer's recommendations. Very slow acting. May be safely applied to soil around certain living plants. Seedlings are more easily injured than older plants. Apply like D-D and EDB or as granules mixed with fertilizer, or apply alone.
25— V-C 13 Nemacide (0-2,4-dichlorophenyl 0, 0-diethyl phos- phorothioate)	Nematodes, insects	Follow the manufacturer's recommendations. May be used as a soil drench around certain living plants, for treating potting soil (1 teaspoon per quart of water treats 1 cubic foot of soil), or as a preplanting treatment. Apply as a drench or as granules and work into the top 6 inches of soil.

TABLE 15
RATES OF APPLICATION OF SPRAYS TO
ROW CROPS

Distance Between Rows	Gallons per Acre	Quarts per 100 Ft. of Row	Feet of Row Covered by One Gallon
1 foot	75	2/3	600
	100	1	400
	125	1-1/6	341
	150	1 1/3	300
	175	1 2/3	240
	200	2	218
3 feet	75	2	194
	100	3	145
	125	3 1/2	116
	150	4	97
	175	5	83
	200	6	73

Row Applications

Rows 12 inches apart—43,560 feet of row per acre.

Rows 24 inches apart—21,780 feet of row per acre.

Rows 36 inches apart—14,520 feet of row per acre.

Rows 48 inches apart—10,890 feet of row per acre.

Example: How much spray does one put on 100 feet of row if the nozzles on the spray boom are 24 inches apart and the recommended application rate is 150 gallons per acre? Calculation: 150 gallons for 21,780 feet = X gallons on 100 feet.

$$X = \frac{(150)(100)}{21,780} = 0.688 \text{ gallons per nozzle}$$

per 100 feet (slightly less than 2 1/2 quarts)

TABLE 16
OPERATING CHART FOR TRACTOR BOOM SPRAYERS

Teejet Tip No.	Pressure (lbs.)	Gallons Per Acre			
		3 MPH	4 MPH	5 MPH	7 1/2 MPH
1/4 T 80015 or 1/4 TT 80015	25	11.7	8.8	7.1	4.7
	30	12.9	9.7	7.7	5.2
100 mesh screen	35	13.9	10.4	8.3	5.6
	40	14.9	11.1	8.9	6.0
1/4 T 8002 or 1/4 TT 8002	25	15.7	11.8	9.4	6.3
	30	17.2	12.9	10.3	6.9
50 mesh screen	35	18.5	13.8	11.1	7.4
	40	19.8	14.8	11.8	7.9
1/2 T 8003 or 1/4 TT 8003	25	23.4	17.6	14.1	9.4
	30	25.8	19.3	15.4	10.3
50 mesh screen	35	27.7	20.7	16.6	11.1
	40	29.6	22.2	17.8	11.8

COMPATIBILITY CHART FOR FUNGICIDES, INSECTICIDES, AND MITICIDES

How To Use This Chart

Use as you would a road mileage chart. For example, if you wish to know whether captan may be safely combined with DDT, read down the vertical column headed "captan" until you come to the horizontal column marked "DDT, etc." The X sign where the two columns meet tells you that captan and DDT may be used together safely. **Warning:** Do not mix fungicides in wettable powder form with liquid concentrates of insecticides.

Key to Symbols

- X = may be safely combined
 - = may not be combined, or use with caution
 . = physically compatible but combination may reduce effectiveness
 O = not necessary in combination
 ? = unknown

Glossary

Acid soil — A soil with an acid reaction or pH. Measurable only by a delicate test. See pH.

Acme Garden Fungicide — A general fungicide for fruit, ornamentals, and vegetables. Contains 30 per cent captan and 3 per cent Karathane.

Acti-dione — An antifungal antibiotic containing cycloheximide. Various formulations are available. Effective against powdery mildews, various rusts, cherry leaf spot, and several lawn diseases.

Active ingredient — The actual toxic agent present in a pesticide.

Aerate — Referring to soil means the loosening of hard compact soil by incorporating organic matter, sand, or other material into it to allow passage of air around the soil particles.

Agar — A gelatin-like material extracted from seaweed. Used for preparing culture media on which microorganisms are grown and studied.

Air drainage — Air outlets and convection currents which prevent "dead" air and frost "pockets."

Alkaline soil — A soil with a basic or sweet reaction. See pH.

Allyl alcohol — See Table 14 in the Appendix.

Alternate host — One of two kinds of plants on which a parasitic fungus (e.g., rust) must develop to complete its life cycle.

Aluminum sulfate — Used to acidify soils: up to 5 pounds per 100 square feet. Plants may develop aluminum toxicity with indiscriminate use. Sulfur is safer to use.

Amobam — A liquid fungicide for use on vegetables. Contains 42 per cent ethylene bis-dithiocarbamate.

Annual — A plant that completes its life cycle from seed in one year and then dies.

Anther — Pollen-bearing portion of the flower.

Anthracnose — A disease caused by fungi that produces spores in a special type of fruit-

ing body (sunken and saucer-shaped). Usually characterized by limited ulcer-like areas on the stem, leaf, or fruit.

Antibiotic — Damaging to life. Especially a chemical substance produced by one microorganism to destroy others (e.g., streptomycin, Acti-dione).

Asexual reproduction — Vegetative reproduction from plant parts other than seeds (or from spores), produced by simple budding as the imperfect stage of certain fungi (e.g., yeasts).

Autoecious — A term used with rusts. Completing the life cycle on only one host plant.

Axillary — In the angle formed by the leaf and stem.

Bactericide — Any chemical which kills or protects from bacteria.

Bacterium (pl. bacteria) — Microscopic, generally one-celled plants which lack chlorophyll. Bacteria, like fungi, cannot manufacture their own food. Some live off dead, organic matter and keep the earth from becoming a "junk yard" of plant and animal remains. Many live in the bodies of plants or animals and cause disease. Bacteria which cause plant disease usually enter through natural openings (water pores or stomates), or through wounds. Bacteria may kill plant cells or cause "cancerous" development of them. See Figure 2. Bacteria multiply by simple fission or division. Some have whiplike flagella which enable them to swim.

Band application — An application of spray, dust, or granules to a continuous restricted area such as to or along a crop row rather than over the entire field area (broadcast).

Bedfume, Bedrench — See Table 14 in the Appendix.

Bichloride of mercury — See mercuric chloride.

Biennial — A plant having a life span of more than 1 year but not more than 2 years.

Biological control — Control of pests by means of predators, parasites, and disease-producing organisms.

Blasting — Causing failure to produce fruit or seeds.

Blight — A general disease term which may include spotting, discoloration, sudden wilting, or death of leaves, flowers, fruit, stems, or the entire plant. Usually young growing tissues are attacked. May be coupled with the name of the host part affected, leading to such common names as blossom blight, twig blight, cane blight, and tip blight.

Blotch — A blot or spot usually superficial and irregular in shape and size on leaves, shoots, and fruit. There is no sharp distinction between leaf blight, leaf blotch, or leaf spot.

Bluestone — See Copper sulfate.

Bordeaux (4-4-50) mixture — The figures following the name of this ancient fungicide discovered near Bordeaux, France, indicate the amounts of copper sulfate, hydrated lime, and water to be mixed. In this case, 4 pounds of copper sulfate and 4 pounds of lime in 50 gallons of water. Homemade mixtures are desirable, but prepared mixtures are available. Leaves a conspicuous residue on plant surfaces. May be injurious to copper-sensitive plants in cold, wet weather. Examples: Acme Bor-Dox, Bordo-mixture.

Bordeaux paint — A fungicidal tree wound dressing. Stir raw linseed oil into dry, wettable bordeaux powder until you get a paste which can be painted on a tree wound.

Botrytis — Genus name for a widespread fungus, which causes blights of peony, tulip, and lilies. See (5) Botrytis Blight under General Diseases. Occurs on many fading flower heads. The gray mold is composed largely of grapelike clusters of spores. Small, hard, black, resting bodies called sclerotia, remain alive in old plant parts or in the soil.

Bract — A modified leaf in a flower cluster (e.g., poinsettia).

Bramble — A cane bush (e.g., raspberry, blackberry) with spines. Fruit is a berry.

Breaking — General term for discoloration of a flower by a virus. The color may be either darker or lighter and in streaks or blotches in a variegated pattern.

Broadcast application — An application of a spray, dust, or granules over an entire area. See also Band application.

Broadleaf — Any plant with a flat leaf. Usually applied to evergreens (e.g., azalea, boxwood, holly, rhododendron) with that sort of leaf rather than the needles found on pines, spruces, and firs.

Broad-spectrum lawn fungicide — One that controls a wide range of lawn diseases when applied correctly.

Bromex, Bromofume, Brozone — See Table 14 in the Appendix.

Bud-break — Resting buds resume growth.

Budding — A special type of grafting using a single bud as a scion.

Bulb — A short, flattened, or disc-shaped, underground stem composed of concentric layers of fleshy scale leaves attached to a stem plate at the base.

Bulblet — Small bulbs produced on the stem at or below the soil line or at the base of an older "mother" bulb.

Caddy — A liquid turf fungicide containing cadmium chloride.

Cadminate — A wettable powder turf fungicide containing cadmium succinate.

Calcium cyanamide — A high nitrogen fertilizer used in soil sterilization.

Callus — Tissue overgrowth around a wound or canker. Develops from cambium or other exposed meristem.

Calo-clor, Calocure — Turf fungicides containing a mixture of calomel (2 parts) and corrosive sublimate (1 part).

Calomel — Mercurous chloride. Used in seed and corm treatments, as a soil drench, and as a turf fungicide.

Calyx — Outermost flower whorl; sepals collectively.

Cambium — A thin layer or cylinder of living cells (meristematic tissue) which divide to form new tissues of the plant. Normally extends over the plant body except at the growing tips. If the cambium layer is destroyed, as sometimes occurs in banding trees, the plant dies.

Cane — The externally woody, internally pithy stem of brambles and vines.

Canker — A definite, dead, often sunken or cracked, area on a stem, twig, limb, or trunk surrounded by living tissues. Cankers may girdle affected parts resulting in a dieback starting from the tip.

Captan — N-trichloromethylthiotetraphthalimide. Widely used as a spray or dust on fruit, ornamentals, turf, and vegetables. Also used as a flower and vegetable seed treatment, and as a postharvest dip for fruits and vegetables. See tables 1, 13, and 14.

Carbon disulfide — An inflammable volatile liquid. Used as a fumigant for borers and as a soil disinfectant for *Armillaria* root rot.

Carrier — A plant or animal carrying internally an infectious disease agent (e.g., virus) but not showing marked symptoms. A carrier plant can be a source of infection to others. An insect contaminated externally with an infectious agent (e.g., bacterium, virus, fungus, nematode) is sometimes called a carrier. Also the liquid or solid material added to a chemical or formulation to facilitate its field use.

Catkin — A type of flower cluster, usually

- bearing only female (pistillate) flowers or only male (staminate) flowers.
- Causal organism** — The organism that produces a given disease.
- Cedar apple** — A popular term given to the hard, brown gall produced on junipers. See (8) Rust under General Diseases.
- Cell** — The structural and functional unit of all plant and animal life. The living organism may have from one cell (bacteria) to billions (a large tree).
- Ceresan 2%** — Contains 2 per cent ethyl mercury chloride; a bulb treatment for narcissus.
- Ceresan 200** — A red liquid containing 6 per cent ethyl mercury 2,3-dihydroxy propyl mercaptide and 1.3 per cent ethyl mercury acetate. Used to control gladiolus corm rots.
- Certification of seed, transplants, cuttings, or other plant parts** — Seed or plants produced and sold under inspection control to maintain varietal purity, freedom from harmful diseases, insect and mite pests.
- Chelates** — Metal-containing compounds useful in supplying deficient minerals to plants. Examples: Versenol and Sequstrene.
- Chemotherapy** — Treatment of disease by chemicals (chemotherapeutics) working internally. The chemical agent has a toxic effect directly or indirectly on the pathogen without injury to the host plant.
- Chem-vape** — See Table 14 in the Appendix.
- Chlamydospore** — A thick-walled spore formed by the modification of a fungus hypha.
- Chloranil** — Tetrachloro-p-benzoquinone. A yellow powder used for seed treatment of flowers and vegetables and as a spray or dust for certain diseases. Sold as Spergon. See tables 1 and 13 in the Appendix.
- Chlorophyll** — The green materials found in leaves and other green plant parts by means of which the plant converts water and carbon dioxide from the air into food utilizing the energy of sunlight in a process called photosynthesis.
- Chloropicrin** — Trichloronitromethane (tear gas), a liquid fumigant which kills all soil-borne pests. See Table 14 in the Appendix.
- Chlorosis (adjective, chlorotic)** — Yellowing or whitening of normally green tissues because of the partial failure of chlorophyll to develop. Chlorosis is a common disease symptom. May be due to a virus, the lack of or unavailability of some nutrient (e.g., iron, manganese, zinc, nitrogen, boron, magnesium), lack of oxygen in a water-logged soil, alkali injury, or some other factor.
- Clone** — A group of plants or horticultural variety derived from one original plant by means of vegetative propagation (e.g., rooting of cuttings or slips, budding, grafting). All plants have the same heredity and are quite uniform when grown under the same conditions. Also the vegetative progeny from a single seedling.
- CM-19** — A fungicide spray for ornamental plants. Contains 17 per cent phenylphenols and related aryl phenols and 2 per cent octyl- and related alkylphenols.
- Coalesce** — The growing or fusing together into one body or spot; sometimes to form a blight or blotch.
- Cold frame** — A plant bed on the ground enclosed by side walls which are usually 8 to 12 inches high and covered with transparent material. The heat comes from sunlight.
- Compatible** — Refers to chemical materials that can be mixed together without changing their effects adversely on pests or plants. A compatibility chart for fungicides and insecticides is given on p. 446 of the Appendix; also different kinds or varieties of plants that will set fruit when cross-pollinated, or make a successful graft union when intergrafted.
- Complete fertilizer** — Any fertilizer containing the three basic elements usually lacking in the soil: nitrogen (N), phosphorus (P), and potassium (K).
- Concentric** — One circle within another with a common center. This is a common symptom of numerous diseases caused by fungi, viruses, and bacteria.
- Conidium (pl. conidia)** — Spore formed from the end of a special spore-bearing hypha.
- Conk** — A forestry term for fruiting bodies (sporophores) of wood-rotting fungi formed on tree stumps, branches, or trunks. See (23) Wood Rot under General Diseases.
- Contagious** — Spreading from one to another.
- Control of plant diseases** — Prevention or alleviation from plant disease. There are four principal methods of control: a. *Exclusion* — Keeping the pathogen away from a disease-free area, through quarantines or disinfection of plants, seeds, or other plant parts. b. *Eradication* — Destruction (roguing) of infected plants or plant parts or killing of the pathogen or agent on or in the host by use of chemicals. c. *Protection* — Application of sprays or dusts to plants to prevent entrance of the pathogen into the plant. d. *Immunization* — Production of resistant or immune plant varieties, chemotherapy, or other treatment to inactivate or nullify the effect of the pathogen inside the plant. See also Section 3.
- Copper naphthenate** — A liquid wood preservative. Sold as Cop-R-Nap, Cuprinol Green No. 10, Ferro Copper Naphthenate 5%, and Rot-Not.
- Copper sulfate (bluestone)** — A blue crystalline material sold as a powder, "snow," small and large crystals. Contains 25 per cent metallic copper. Used to make bordeaux mixture, as a disinfectant for potato sacks and storage areas, and in ponds to kill algae.

- Corm** — A short, solid, underground stem (e.g., gladiolus). True bulbs (e.g., onion, tulip, hyacinth) are composed of fleshy scales. Corms are solid.
- Cormel** — A tiny corm produced around the base of the mother corm.
- Corrosive sublimate** — See mercuric chloride.
- Cover crop** — Plants grown to improve and maintain soil structure, add organic matter, and prevent soil erosion.
- Crown gall** — A tumor-like enlargement of roots or stem caused by bacteria. See (30) Crown Gall under General Diseases.
- Crown rot** (Southern blight) — A disease caused by a fungus which attacks hundreds of different ornamentals and vegetables under warm moist conditions. White webs of mycelium spread fanwise up the stem from the crown and also out into the soil. See (21) Crown Rot under General Diseases.
- Crucifers** — Members of the cabbage family including cabbage, broccoli, Brussels sprouts, cauliflower, horseradish, rape, kohlrabi, turnip, alyssum, honesty, and stock.
- Cucurbits** — Members of the cucumber family including cucumber, melons, squash, pumpkins, gourds, and watermelon.
- Culture** — To artificially grow organisms (e.g., fungi, bacteria, and nematodes) on a prepared food material such as agar or broth (culture medium), or on living plants. The entire process of obtaining an organism (such as a tree wilt-producing fungus) on prepared media is often called culturing.
- Cuprinol** — See Copper naphthenate.
- Curl** — The distortion, puffing, and crinkling of a leaf resulting from the unequal growth of its two sides. See (10) Leaf Curl under General Diseases.
- Curly-top** — A common virus disease in western states. Plants are stunted with curled and mottled leaves. See (19) Curly-top under General Diseases.
- Cyanamid** — See Calcium cyanamide.
- Cyprex** — See Dodine.
- Damping-off** — Decay of seeds in the soil or young seedlings before or after emergence. Most evident in young seedlings that suddenly wilt, topple over, and die from a rot at the stem base. Woody seedlings often wilt and remain upright. Generally caused by seed- and soil-borne fungi. See (21) Crown Rot under General Diseases.
- DBCP** — See Table 14 in the Appendix.
- D-D Soil Fumigant** — A mixture of 1,2-dichloropropane and 1,3-dichloropropene. Used to control nematodes and some soil insects. See Table 14 in the Appendix. Examples include Ortho D-D Soil Fumigant, Stauffer D-D Soil Fumigant, and Shell D-D Soil Fumigant.
- Deciduous** — Plants that drop their leaves in the fall, or once a year, as compared with evergreens that retain their leaves (needles) for two years or longer.
- Defoliate** — To lose or become stripped of leaves.
- Delayed dormant spray** — One applied to fruit trees, raspberries, other fruits, and shade trees when the new green tips are $\frac{1}{8}$ to $\frac{1}{4}$ inch out.
- Desiccation** — Drying out.
- Dexon WP** — A seed treatment and soil fungicide. Contains 70 per cent p-dimethylaminobenzene diazo sodium sulfonate.
- Diagnosis** — Identification of the nature and cause of a plant trouble.
- Dichlone** — 2,3-dichloro-1,4-naphthoquinone. A yellow powder used especially as a spray or dust for apples, stone fruits, and certain vegetables. May cause injury in hot weather. See Table 1. Also useful as a seed treatment (Table 13 in the Appendix).
- Dieback** — Progressive death of shoots and branches generally starting at the tips. May be due to cankers, stem rots, borers, nematodes, winter injury, deficiency or excess of moisture or nutrients, or some other factor.
- Dinitro materials** — Semi-liquid eradicant fungicides. Example: Elgetol (contains 19 per cent sodium dinitro-o-cresol). Useful as a dormant and delayed dormant spray for control of certain diseases of apple, ornamental shrubs, and trees.
- Dioecious** — Male and female flowers on different plants.
- Disease, plant** — A continuously affected condition in which any part of a living plant is abnormal (e.g., structure, function, or economic value) or which interferes with the normal activity of the plant's cells or organs. Injury, in contrast, results from a momentary damage. This is, perhaps, not the best definition, but it is one which is generally accepted with minor changes. Diseases may be caused by living pathogens, viruses, improper environmental conditions, and a few higher parasitic plants such as dodder, broom rape, mistletoes, and witchweed. See also Section 2 which covers symptoms and controls.
- Disinfectant** — A material that kills microorganisms (fungi, bacteria, nematodes) once a plant, or any of its parts, has become infected or infested. See also Chemotherapy.
- Disinfection** — Freeing a diseased plant or plant parts from infection. Or the destruction of a disease agent or disease-inducing organism in the immediate environment of the host plant.
- Disinfestant** — A material that removes, kills, or inactivates disease-causing organisms before they can cause infection. It may be applied on the surface of a seed, other plant part, or in the soil.
- Dissemination** — The spread of infectious material (inoculum) from a diseased to a

- healthy plant by wind, water, man, insects, animals, machinery, or other means.
- Dithane M-22, Z-78** — See Table 1.
- Dodder** — Also called gold thread, strangle-weed, hell-bind, and love vine. See (40) Dodder under General Diseases.
- Dodine** — n-dodecylguanidine acetate; wet-table powder used as a fungicide, especially for apple, pecan, cherries, and roses. Sold as Cyprex 65-W Dodine.
- Dorlone** — See Table 14 in the Appendix.
- Dormant period** — Time during which no growth occurs.
- Dormant spray** — A spray applied when plants are in a dormant condition.
- Dosage** — See Rate.
- Double working** — Grafted twice. A variety is grafted to an intermediate stock.
- Dowfume** — See Table 14 in the Appendix.
- Dwarfing** — The underdevelopment of a plant or plant organs. May be caused by any type of disease agent under certain conditions.
- Dyrene** — A wettable powder fungicide. Used as a fungicide for vegetables, lawns, and gladiolus. Contains 50 per cent 2,4-dichloro-6-o-chloroanilino-s-triazine.
- EDB** — See Ethylene dibromide.
- Eelworms** — See Nematodes.
- Elgetol** — See Dinitro materials.
- Embryo** — A beginning young plant, usually contained in a seed or surrounded by protective tissue.
- Emergence** — Appearance of the shoot above the soil surface.
- Emmi** — A liquid fungicide used for treating narcissus bulbs and gladiolus corms. Contains 10.34 per cent n-ethylmercuri-1,2,3,6-tetrahydro-3, 6-endomethano-3, 4, 5, 6, 7, 7-hexachlorophthalimide.
- Emulsifiable liquid** — One that will form an emulsion when mixed with water. May cause plant injury when combined with a wettable powder in a single spray. See compatibility chart of fungicides and insecticides in the Appendix.
- Emulsion** — A mixture in which one liquid is dispersed as minute globules in another liquid.
- Enphytotic** — A plant disease which causes about the same amount of damage every year.
- Epidermis** — The outermost layer of cells of a leaf, stem, or other young plant organs.
- Epiphytotic** — The sudden and destructive development of a plant disease, usually over large areas. Corresponds to an epidemic of a human disease.
- Eradicant fungicide** — A chemical or physical agent which destroys a fungus at its source, e.g., after its establishment within a plant host.
- Eradication** — Control of disease by eliminating the pathogen after it is already established. See also Control of plant diseases.
- Escape** — Plants in a given population (e.g., field or garden) of a species or variety which remain free of disease where it is prevalent, although they possess no natural inherent resistance to the disease. Plants may escape attack because of the way they grow (e.g., early maturing plants escape late season diseases).
- Ethylene dibromide** — A soil fumigant for controlling nematodes, soil insects, and other pests. See EDB in Table 14 in the Appendix.
- Etiolation** — Excessive yellowing (often spindliness) in plants due to a lack of light.
- Etiology** — The study or description of the cause of disease.
- Evergreen** — Plants which retain their functional leaves throughout the year.
- Exanthema** — A name for copper deficiency in fruits.
- Exclusion** — Control of disease by preventing its introduction (e.g., by quarantines) into disease-free areas. See Control of plant diseases.
- Exudate** — A substance (usually liquid) formed inside a plant and discharged from diseased or injured tissues. The presence of an exudate often aids in diagnosis (e.g., fire blight).
- F₁** — The first generation progeny of a cross.
- Facultative parasite** — See Parasite.
- Fasciation** — A distortion of a plant caused by an injury or infection which results in thin, flattened, and sometimes curved shoots. The plant may look as if several of its stems were fused.
- Feeder roots** — Fine roots with a large absorbing area (root hairs).
- Ferbam** — Ferric dimethyl dithiocarbamate. A black powder used in fungicide sprays and dusts and soil drenches. See Table 1.
- Fertilizer** — Any material containing nutrients available to plants. To be labeled and sold as such it must be state-licensed with the analysis printed on the package label.
- Fire blight** — A common bacterial disease which attacks pomes and many ornamental shrubs in the rose or apple family. Affected portions turn black or brown and appear to have been scorched by fire. See (24) Fire Blight under General Diseases.
- Fixed copper** — A relatively insoluble form of copper used as a spray, dust, or drench. The addition of spray lime may be necessary on some crops. See also in Section 3.
- Flag (flagging)** — A branch with drooping or dead leaves on an otherwise healthy-appearing tree.
- Flagellum (pl. flagella)** — A tiny, whiplike filament produced by a cell (certain bacteria and spores of the lower fungi) which enable the cell to swim through a liquid. See Figure 2.
- Flozon Tree Wound Paint** — See Gilsonite-varnish wound dressing.
- Foliage** — The leaves of a plant.

Foliar feeding — Applying liquid nutrients to the leaves. Often applied in pesticide sprays.

Forcing crops — Those grown out of season indoors.

Formaldehyde (formalin) — A 37-40 per cent solution in water and methanol; used for soil and seed treatments and for disinfesting potato sacks, bins, equipment, and storage areas. Examples: DuPont Formaldehyde Solution, Parsons U.S.P. Formaldehyde, and B. and A. Formaldehyde.

Foundation planting stock — A stock of high quality grown separately and very carefully rogued to produce daughter plants for sale.

Frass — The wet or dry sawdust-like material excreted by borers. Usually evident at their exit holes.

Fruiting body — A complex fungus structure that contains or bears spores. There are numerous types.

Fumazone — See Table 14 in the Appendix.

Fumigant — A volatile disinfectant which destroys organisms by a gas or vapor. See Table 14 in the Appendix.

Fungicide — A chemical or physical agent that kills or inhibits fungi (often used in a broad sense to include bacteria). Captan, zineb, bordeaux mixture, fixed copper, maneb, ferbam, sulfur, and lime-sulfur are fungicides. May be used as disinfectants or eradicants to kill fungi in soil or seed or rarely in plants. Usually applied as protectants covering susceptible plant parts before the pathogen can infect.

Fungistatic — A chemical or physical agent which prevents development of fungi without killing them.

Fungus (pl. fungi) — A low form of plant life which, lacking chlorophyll and being incapable of manufacturing its own food, lives off dead or living plant or animal matter. The body of a fungus consists of delicate, microscopic threads known as *hyphae*, many of which form branched systems called *mycelia* often evident to the naked eye. The mycelia which may form inside or on the surface of the plant host have different branching habits and structures which help to identify the fungus. Many fungi multiply by forming *spores* at the ends of, within, or on specialized hyphae. The spores are microscopic bodies that function like the seeds of higher plants and are carried by water, wind, man, insects, animals, and machinery. A spore landing on a plant under the proper conditions (usually moderate temperature and a film of moisture) can produce a new fungus body (Figure 3). Many fungi produce both sexual and nonsexual (asexual) spores. The manner of production of the sexually formed spores is the basis of classification of fungi into three of their main groups: Phycomycetes, Ascomycetes, and

Basidiomycetes. Sexually produced spores have not been found in the fourth main group, the Fungi Imperfici. Spores are not known for some fungi, which have been classified in a fifth group, the Mycelia Sterilia. See Figure 3.

Gall — An abnormal outgrowth or swelling of plant tissue (often of unorganized plant cells) due to irritation by insects, mites, bacteria, fungi, viruses, or nematodes. Often more or less spherical in shape. Examples: black knot, crown gall, cedar-apple gall, root-knot.

Garden Dowfume — See Ethylene dibromide.

Gene — The unit of inheritance transmitted from parent to offspring which controls the development in the offspring of one or more characteristics in the parent.

Genus — A group of related species. See Species and Plant family.

Germicide — A substance that kills microorganisms.

Germination — The beginning of growth. See germ tube.

Germ tube — The hyphal thread produced by a germinating fungus spore. It may grow into a plant through a natural opening or wound or penetrate directly through the unbroken epidermis. The hyphal thread grows, branches, and becomes the new fungus body. See Figure 3.

Gerox — A soil drench for control of certain ornamental diseases. Contains 25.3 per cent streptomycin sulfate and 31.8 per cent 8-hydroxyquinoline citrate.

Gilbert's Tree Wound Dressing — Contains 6 per cent phenols. For use on plane trees where canker stain is a problem.

Gilsonite-Varnish Wound Dressing — Used as a wound dressing on plane trees. Federal specification TT-V-51 Gilsonite Varnish plus 0.2 per cent phenylmercury nitrate. Example: Flozon Tree Wound Paint.

Girdle — A canker which surrounds a stem, completely cutting off water or the nutrient supply and thus causing death. Girdling roots of trees may also cause death.

Glyodin — A liquid fungicide used as a spray to control fruit diseases. Contains 30 per cent 2-heptadecyl glyoxalidine acetate. Example: Crag Glyodin.

Graft indexing — A plant is grafted to another plant to determine the presence or absence of a virus. The method detects the presence of viruses not readily transmitted mechanically.

Graftage — Method of inserting buds, twigs, or shoots in other stems or roots for fusion of tissues.

Ground cover — Any plant used to cover the ground, hold soil, and give foliage texture (e.g., ivy, pachysandra, vinca) usually as a substitute for grass.

Growing season — The period between commencing of growth in the spring to cessation of growth in the fall.

Growth regulator (plant regulator) — A hormonal substance capable of changing the growth characteristics of plants.

Grub — The larva of a beetle.

Gummosis — Exuding of sap, gum, or latex from inside a plant. Often due to a parasite working within the plant. May also be due to unfavorable growing conditions or other environmental factors.

Guttation — The normal forcing out or exuding of moisture (cell sap) from an uncut plant surface. Microorganisms thrive in this moisture and many enter plants through the opening as the guttation drop is "reabsorbed" by the plant.

Hairy root — The development of large numbers of small roots on a limited area of a root. See (30) Crown Gall under General Diseases.

Hardening, Hardening-off — Subjecting plants to unfavorable conditions to hasten maturing of tissues for increasing hardiness.

Hardiness — The quality which causes plants to resist injury from unfavorable temperatures.

Hardpan — An impervious layer of soil or rock which prevents downward drainage of water.

Haustorium (pl. **haustoria**) — Special root-like, food-absorbing, sucking organs produced by dodders, mistletoes, and certain fungi which grow into a plant or host cell by means of which food is obtained from the host plant.

Heading back — Pruning off the terminal part of a twig or branch.

Healing over — The process whereby a wound is closed or protected by a new growth (callus) without replacing the lost parts.

Heartwood — The central cylinder of xylem tissue in a wood stem or trunk.

Herbaceous — Plants with soft, nonwoody stems (e.g., annuals, biennials, and perennials) that normally die back to the ground in the winter.

Herbicide — Any chemical or agent used for killing or inhibiting the growth of weeds.

Heteroecious — Pertains to the rust fungi which require two or more unrelated hosts for completion of the life cycle. See (8) Rust under General Diseases.

Heterozygous — Having mixed hereditary factors. Not a pure line.

Homozygous — Purity of type. A pure line.

Honeydew — A sweet sticky secretion given off by aphids, whiteflies, scales, and other insects. An attractant for ants, and a favorable medium for black, sooty mold fungi. See (12) Sooty Mold under General Diseases.

Hopperburn — Marginal yellowing, scorching, and curling of potato, dahlia, and other foliage due to the feeding of leafhopper insects.

Hormone — A naturally occurring or syn-

thetic compound which stimulates plants in a specific manner.

Horticulture — The art and science dealing with fruits, vegetables, flowers, ornamentals, shrubs, and trees.

Host — Any plant attacked by (or harboring) a living parasite and from which the invader is obtaining its nourishment. See Suscept.

Host indexing — A procedure to determine whether a given plant is a carrier of a virus disease. Material is taken from one plant and transferred to another plant that will develop characteristic symptoms if affected by the virus disease in question.

Host range — The various kinds of plants attacked by a given parasite.

Hotbed — Similar to cold frames but provided with a source of heat (electricity, fermenting organic matter, steam, hot air) to supplement sunlight.

Humidity, relative — The weight of water vapor in the air as compared to the total weight of water vapor which the air is capable of holding at a given temperature.

Humus — Decomposing organic matter from any source which may become fine, rich, black earth. May come from vegetable refuse, leaf mold, manure, and peat.

Hybrid — The first generation progeny from a cross of different varieties, strains, or inbred lines.

Hydathode — Special structures through which water of guttation can easily escape. Microorganisms can also enter through these natural openings.

Hydrogen-ion concentration — A measure of the acidity of a chemical in solution. It is expressed in terms of the pH of the solution. See pH.

Hygiene — See Sanitation.

Hyperplasia (adjective, **hyperplastic**) — A term applied to a disease producing an abnormal increase in the *number of cells* (without their enlargement) resulting in the forming of galls or tumors.

Hypertrophy (adjective, **hypertrophic**) — An abnormal increase in the *size* of an organ or tissue brought about by enlargement of the component cells or by an increase in cell division or both.

Hypha (pl. **hyphae**) — A single thread or filament which constitutes the body (mycelium) of a fungus. It may be divided into cells by cross walls or be one long cell. Some hyphae are specialized for producing spores, penetrating host tissues, overwintering, or trapping nematodes.

Hypoplasia (adjective, **hypoplastic**) — A term applied to a disease resulting in the underdevelopment of plant cells, tissues, or organs due to subnormal cell production.

Immune (immunity) — The ability of a plant to remain exempt from disease due to inherent properties of the plant (e.g., tough

- outer wall, hairiness, nature of natural openings, waxy coating).
- Immunization** — The process of increasing the resistance of a living organism.
- Incompatible** — Pertains to different kinds or varieties of plants that do not successfully cross-pollinate or intergraft.
- Incubation period** — The time between inoculation of a plant by a disease-producing agent and the appearance of visible symptoms. This period may vary from a few hours to as long as a year or more. Another meaning — the maintaining of inoculated plants or pathogens in an environment favorable for disease development.
- Indexing** — Determining the presence of a disease. See Graft indexing and Host indexing.
- Infect (infection)** — The process of becoming established in a parasitic relationship with a host plant.
- Infection court** — Any place where an infection may take place (e.g., leaf, fruit, petal, stem).
- Infest** — To be present in numbers (e.g., insects, mites, nematodes). Do not confuse with infect (infection) which applies only to living, diseased plants or animals.
- Inflorescence** — The flowering structure of a plant.
- Injury** — Momentary damage to a plant by an adverse factor (e.g., insect or rodent bite, action of a chemical, physical, or electrical agent).
- Inoculate (inoculation)** — Bringing infectious material (inoculum) in contact with a host plant (infection court).
- Inoculum** — The infectious agent, pathogen, or its part (e.g., spores, mycelium) which is capable of infecting plants.
- Insecticide** — A chemical or physical agent that kills, inhibits, or protects against insects. Examples: DDT, lindane, malathion, methoxychlor.
- Insect vector** — An insect which transmits a disease-inducing organism or agent.
- Internode** — The part of a stem between the nodes.
- Intumescence** — A knoblike blister or pustule formed by outgrowths of elongated cells on leaves, stems, or other plant parts, that have burst from sudden water excess following dry periods.
- Invasion** — Growth or movement of an infectious agent into a plant and its establishment in it.
- Karathane** — A chemical specifically for control of powdery mildew. Contains dinitro phenyl crotonate. See section 3.
- Knot** — Knoblike overgrowth on roots or stems with an imperfect vascular system.
- Kromad** — A broad-spectrum turf fungicide containing 5 per cent cadmium sebacate, 5 per cent potassium chromate, 1 per cent malachite green, 0.5 per cent auramine, and 16 per cent thiram.
- Larva (pl. larvae)** — The immature form of certain insects. Larvae hatch from eggs, are wingless, often wormlike or grublike, and develop into a pupal or chrysalis stage.
- Larvacide** — See Table 14 in the Appendix.
- Leaching** — The washing of soluble nutrients down through the soil.
- Leaf spot** — A definitely delimited lesion on a leaf. There are thousands of different kinds of leaf spots caused by hundreds of fungi plus some bacteria and viruses. Usually the damage is not severe enough to warrant special control measures. See (1) Fungus Leaf Spot and (2) Bacterial Leaf Spot under General Diseases.
- Lesion** — A localized area of diseased tissue. Spots, cankers, blisters, and scabs are lesions.
- Lichen** — A fungus living together with a green or blue-green alga in a symbiotic relationship. The fungus receives food from the alga which in turn gets protection and food from the fungus. Lichens grow on living trees and shrubs. Most abundant in the south where they flourish in shady, damp locations in neglected garden plantings. Lichens may be disfiguring and when abundant interfere with normal light and gas exchange. Remove, where necessary, by rubbing when moist or by spraying with a copper-containing fungicide.
- Life cycle** — The complete succession of events in the life of an organism.
- Lime** — Hydrated spray lime is sometimes used in combination with a pesticide (especially bordeaux mixture and fixed copper). Ground limestone is used to check soil acidity. Lime-induced chlorosis may occur when acid-loving plants (e.g., azaleas, rhododendrons, and blueberries) grow near a concrete foundation or in alkaline soil.
- Lime-sulfur (liquid)** — Formed by boiling sulfur and milk of lime together. An old fungicide now largely replaced by safer materials, e.g., captan, zineb, manebe, ferbam, and ziram. Liquid lime-sulfur is still used as a dormant or delayed dormant spray on certain stone fruits, apples, and bramble fruits. See Section 3. Contains 26 to 30 per cent solution of calcium polysulfides. Examples: F. & B. Lime Sulphur Solution, Miller Lime Sulfur Solution, Orthorix Spray.
- Lister** — A plow used for ridging.
- Local infection** — Infection involving only a limited part of a plant (e.g., leaf spot, scab).
- Macroscopic** — Visible to the naked eye. See also Microscopic.
- Maneb** — Manganese ethylene bisdithiocarbamate. A grayish-yellow wettable powder used as a dust or spray to control various

diseases of vegetables and ornamentals. See Table 1.

Maturity — The state of ripeness. Usually refers to that stage of development which results in maximum quality.

Mercuric chloride — Also known as corrosive sublimate and bichloride of mercury. Sold either as a white powder or as tablets usually blue in color. When diluted 1:1,000, 1:2,000, or 1:3,000 is used as a seed treatment or as a soil drench. A 1:1,000 solution is made by dissolving 1 ounce in $7\frac{1}{2}$ gallons of water. For preparing small amounts accurately, dissolve one 7.3 to 8 grain tablet in 1 pint of water. See Section 3 and page 427 in the Appendix. *This is a deadly poison — use with caution.*

Mersolite 8 — Contains phenylmercury acetate. Used to soak narcissus bulbs.

Methocel — Methyl cellulose 15 C.P.S. Available as a powder or fiber. Used as a sticker in seed treatment and for pelleting seed (e.g., onion).

Methyl bromide — See Table 14 in the Appendix.

Mico-Fume — See Table 14 in the Appendix.

Micron — A unit of length equal to 1/1,000 of a millimeter or 0.00003937 of an inch long. Used for measuring fungus parts, bacteria, nematodes, and other microscopic objects.

Microscopic — Visible only under the microscope. See also Macroscopic.

Mildew — A plant disease characterized by a thin whitish coating of mycelial growth and spores on the surface of infected plant parts (downy and powdery mildews).

Mildew King — A liquid fungicide for control of rose powdery mildew. Contains 30 per cent copper oleate.

Miller 658 Fungicide — A wettable spray powder fungicide containing 95 per cent copper zinc chromate complex.

Mistletoe — See (39) Mistletoe under General Diseases in Section 2.

Mold — Any fungus with conspicuous, profuse, or woolly growth (mycelium or spore masses). Occurs most commonly on damp or decaying matter and on the surface of plant tissue.

Monocious — Plants having separate staminate (male) and pistillate (female) flowers or reproductive organs on the same individual. In rusts, all stages of the life cycle occur on a single species of plant. See also Heteroecious, and (8) Rust under General Diseases.

Mosaic — A virus disease characterized by a mottling of the foliage or by variegated patterns of dark green to yellow which form a mosaic.

Mottle — An irregular pattern of light and dark areas.

Mulch — A layer of some substance such as straw, dry leaves, or sawdust on top of the

soil. Often used to catch rainfall, prevent splashing, retain moisture, control weeds, keep the soil temperature down in summer, keep produce clean, or for some other reason.

Multipurpose spray or dust — One that controls a wide range of pests. See in Section 3.

Mummy — A dried shriveled fruit, the result of some fungus disease such as brown rot or black rot. The mummy may hang on the tree or fall to the ground where it survives the winter and is the source of reinfection in spring.

Mushroom (toadstool) — A conspicuous fleshy fungus, especially one with gills. The aboveground part is the reproductive part of the fungus. The word properly applies to all fruiting bodies whether edible, poisonous, tough and unpalatable, or leathery.

Mutation (bud sport) — A genetic change within an organism or its parts which changes its characteristics.

Mycelium (pl. mycelia) — The mass of threads (hyphae) making up the vegetative body of a fungus. The mycelia of fungi show great variation in appearance and structure.

Mycology — The science dealing with fungi.

Mycorrhiza (pl. mycorrhizae) — A generally mutually beneficial relationship (symbiosis) between roots and fungi. Many plants cannot grow normally without the presence of mycorrhizal fungi.

Mylone — See Table 14 in the Appendix.

Natriphene — A fungicide containing 100 per cent sodium salt of 2-hydroxy diphenyl. Used to control damping-off of ornamentals.

Necrotic (necrosis) — Having symptoms characterized by the death or disintegration of plant cells or tissues. When several cells die together a spot or lesion is formed. If the lesion is sunken and ugly, it is often called a canker. If the lesion is small, white, and translucent it is called a fleck.

Needle cast — Disease of evergreens which results in a large drop of needles. Often called needle blight.

Nemadrench, NemaFume, Nemagon — See Table 14 in the Appendix.

Nematicide — A chemical or physical agent that kills, inhibits, or protects against nematodes.

Nematodes (nemas, eelworms, or round-worms) — Generally microscopic tubular animals usually living free in moist soil, water, and decaying matter or as parasites of plants and animals. Responsible for many plant diseases. Nematodes that cause plant disease pierce the cells of a plant with a stylet and suck up juices. Nema-

todes also play a role in providing wounds by which other pathogens may enter and also transmit disease-producing organisms and viruses into plants. See (20) Leaf Nematode, (37) Root-knot, and (38) Bulb Nematode under General Diseases. Controlled by soil fumigation. See Table 14 in the Appendix. Rotation and hot water treatment of bulbs or other plant parts are other control measures.

Nemex — See Table 14 in the Appendix.

Neutral soil — One whose reaction is neither acid or alkaline. See pH.

Node — A slightly enlarged portion of the stem where leaves and buds arise, and where branches originate.

Nodule — A lump, knot, or tubercle.

Non-infectious disease — A disease that cannot be transmitted from one plant to another. A disease caused by a physiogenic agent (physical or environmental factors).

Nursery — An establishment for growing, handling, or retailing plants.

Nutrients — Elements available to plants through soil, air, and water which are utilized in growth.

Obligate parasite — See Parasite.

Oedema — A swelling or a disease in plants sometimes caused by overwatering in cloudy weather when there is reduced evaporation (transpiration). See page 28.

Omazene — A wettable powder fungicide used as a spray to control powdery mildew of roses. Contains 50 per cent copper dihydrazinium sulfate.

On the dry side — Keeping the soil or planting medium barely moist as compared to keeping it rather wet. One of the recommended procedures to keep losses from seed rot, damping-off, and seedling blight at a minimum.

Organic matter — Any plant or animal material which is decomposed, partially decomposed, or undecomposed.

Ornamental plants — Those grown for accent, attraction, beautification, color, screening, specimen, and other aesthetic reasons.

Ortho Lawn and Turf Fungicide — A multipurpose turf fungicide containing 60 per cent phaltan, 5 per cent cadmium carbonate, and 10 per cent thiram.

Orthocide 50 Wettable, Orthocide 75 Seed Protectant, Orthocide Fruit and Vegetable Wash — See Table 1.

Orthocide Karathane 50-6 Fungicide — A multipurpose fungicide for fruit, vegetables, and ornamentals. Contains 50 per cent captan and 6 per cent Karathane.

Orthocide Soil Treater "X" — A fungicide for the control of soil-borne diseases. Contains 10 per cent captan and 10 per cent PCNB (pentachloronitrobenzene).

Orthorix Spray — See Lime-sulfur.

Oxyquinoline sulfate — A soil fungicide. Used as a drench to control damping-off and

other soil-borne diseases. Examples: Sunox and Fulex A-D-O.

Pano-brome, Pano-drench — See Table 14 in the Appendix.

Panoram — See Table 1.

Parasite — An organism that lives on or in another organism and obtains all or part of its nutrients from it. Many fungi have both parasitic and saprophytic stages. True rusts, white-rusts, and powdery mildews are obligate parasites, having no saprophytic stage. Rusts and powdery mildews can live only in living tissues. *Facultative parasites* are organisms that can grow either on living or dead organic matter. *Obligate parasites*, on the other hand, can live only in living matter or on it.

Parasitic plant — One which derives all or part of its nutrients from another on which or in which it lives. See Parasite.

Parzate C, Parzate Zineb Fungicide — See Table 1.

Pathogen — Any organism or agent capable of causing disease. Most pathogens are parasites but there are a few exceptions.

Pathogenic — Capable of causing disease.

Pathology — The science of disease.

PCNB — Pentachloronitrobenzene. Sold principally as Terraclor for use as a dust, spray, or soil drench to control various diseases of vegetables and ornamentals. See in Section 3 and Table 14 in the Appendix.

Peanut peg — The fruit-bearing stalk.

Peatmoss — An excellent mulch. Widely used to help "lighten" a heavy soil. Difficult to wet. Care must be taken to prevent its drying out entirely for then the mulch absorbs water in the soil away from plant roots.

Pentachlorophenol — A liquid wood preservative for preventing wood rots. Sold as a 4 to 5 per cent solution under such trade names as Bonide Pentide, Miller PCP-10, Pentox, and Wood Tox. Also sold as a concentrate under various trade names.

Perennial — Any plant that has a life span of more than two years.

Pest — Any organism injuring plants or plant products.

Pesticide — Any chemical or physical agent that destroys pests (e.g., fungicide, insecticide, miticide, nematocide, herbicide).

Pesticide tolerance — The established quantity of a pesticide that can legally remain on harvested, edible products in interstate commerce. Tolerances are set by the Pure Food and Drug Administration in Washington, D.C.

Pestmaster — See Table 14 in the Appendix.

Petiole — The stalk of a leaf.

pH — A symbol of a scale used to designate the relative acidity of a solution. The scale ranges from 1 to 14. pH 7.0, the midpoint, represents a neutral solution. Numbers less than 7 indicate increasing acidity; those more than 7, increasing alkalinity.

You can test soil yourself with a simple test kit, available at many garden supply stores. Or you can have it done at your local county extension office or state agricultural experiment station.

Phaltan — N-trichloromethylthiophthalimide. A wettable powder for the control of ornamental diseases (especially roses). Also useful on fruits, potatoes, and as a seed treatment. See in Section 3.

Phenyl mercury compounds — Liquids and wettable powders containing various salts of phenyl mercury. Used as sprays for the control of diseases of apple, ornamentals, and turf and as a seed treatment. See also in Section 3 and Table 13 in the Appendix.

Phloem — Tissue in plants through which foods are transported from the leaves to the roots. See Xylem. Phloem is the inner bark of woody plants.

Photoperiodism — Response of plants to the daily length of light.

Photosynthesis — The complicated processes by which green plants make sugar from water and carbon dioxide in the air through the energy of sunlight. See Chlorophyll.

Phygon — See Table 1.

Physiogenic disease — A disease produced by some unfavorable physical or environmental factor (e.g., excess or deficiency of light, temperature, water, soil nutrients).

Physiologic race — A subdivision within a species of fungus that differs in virulence, symptom expression, or to some extent in host range, from other races (or strains) and the rest of the species. Frequently after a new variety of a plant (e.g., potato) has been bred for resistance to a species of fungus (e.g., late blight), the organism in turn develops (principally through hybridization or mutation) a new race which attacks the variety at will.

Phytopathology — Plant pathology or the science of plant disease.

Phytotoxic — Injurious to plants.

Picfume — See Table 14 in the Appendix.

Pinch, Pinching back — Removing the tip of a stem, an extra flower bud, or tip bud using fingernails, knife, or shears. This stimulates lateral growth.

Pistillate flower — One that contains pistils (female parts) but no stamens (male parts).

Plant family — A group of related genera. Plants are classified according to their flower or sexual structures.

Pome — Fruit with an embedded core like apple, pear, and quince.

Powdery mildew — Fungi which form a white coating on the surface of leaves, stems, buds, and flowers. See (7) Powdery Mildew under General Diseases.

PPM — Parts per million.

Primary infection — The first infection by a pathogen after it has gone through a rest-

ing or dormant period. See Secondary infection.

Procumbent — Nearly prostrate. Spreading.

Progeny — The young or seedlings of a plant.

Protectant — A chemical applied to the plant surface in advance of the pathogen to prevent infection.

Pruning — The judicious removal of leaves, shoots, twigs, branches, or roots of a plant to increase its usefulness, vigor, or productivity.

Pupa — An intermediate resting stage during which an insect changes from a larva to an adult.

Pustule — Blister-like or pimple-like structure that may rupture the epidermis and expose the causal agent (e.g., rust, smut, white-rust).

Quarantine — Regulation forbidding sale or shipment of plants or plant parts, usually to prevent disease, insect, nematode, or weed invasion of an area.

Race or Strain — A subgroup within a species of fungi, bacteria, or viruses that differs in virulence, symptom expression, or to some extent in host range from other races (or strains) and the rest of the species. See Physiologic race.

Rate and Dosage — Synonymous terms. Usually refers to the amount of active ingredient applied to a unit area (e.g., acre or 1,000 square feet) regardless of percentage of chemical in the carrier.

Renewal (replacement) spurs — Grape canes near the trunk cut back to two buds to provide new fruiting wood in a desired location.

Renovation — To invigorate or rejuvenate, thin plants, remove weeds, and form new plants (e.g., in a strawberry bed).

Resistant (resistance) — The sum of the inherent qualities of a host plant that retard the activities of the causal agent. A plant may be slightly, moderately, or highly resistant. The ability of a host plant to suppress or retard the activity of a pathogen.

Respiration — Oxidation or utilization of foods by plants and animals resulting in energy release. Carbon dioxide, water, and other materials are liberated.

Rhizoid — A rootlike structure.

Rhizome — An elongate, underground, horizontal stem which forms both roots and shoots at its nodes.

Rhizomorph — A cordlike strand composed of a bundle of fungus hyphae, by which the fungus makes its way for considerable distances through the soil or along under the bark of woody plants or elsewhere. Example: Armillaria root rot fungus.

Ringspot — Symptom of disease characterized by yellowish or dead (necrotic) rings with green tissue inside the ring as in certain virus diseases. See (17) Spotted Wilt under General Diseases.

Rogue (roguing) — To remove and destroy undesired or diseased individual plants from a planting on the basis of disease infection, not true-to-type, insect infestation, or other reason.

Root-knot — A nematode-caused disease characterized by galls on the roots. Usually most commonly found in sandy soils attacking hundreds of kinds of plants. See (37) Root-knot under General Diseases. Also the name of several species of nematodes.

Rootone F — Contains growth promoting substances and 4 per cent thiram. Used on cuttings, seeds, and bulbs.

Rootstock — The fleshy root of a herbaceous perennial plant with buds and eyes.

Rosette — A symptom of disease with stems shortened to produce a bunched growth habit.

Rot — State of decomposition and putrefaction. May be dry and firm to mushy and slimy. Caused by an organism disintegrating large numbers of living cells. Usually caused by fungi and bacteria.

Root-Not — See Copper naphthenate.

Rugose — Rough. Used as part of the names of certain virus diseases characterized by warty, roughened, or severely crinkled leaves or other plant parts.

Runner — A horizontal stem that grows close to the soil surface.

Russet — Brownish, roughened, or corky areas on the skin of leaves, fruit, or tubers, as a result of disease, insects, or spray injury.

Rust — A disease caused by a rust fungus, or the fungus itself. The life cycle of a rust fungus may involve up to five different types of spores. Rusts may parasitize one species of plant during their lives (*autoecious* or *monoecious*) or two types of species (*heteroecious*). A rust that is heteroecious and has five types of spore forms (numbered 0 to IV) is the stem rust of grasses. The five spore types are the reddish-brown *urediospores* (II) which spread the rust from grass plant to grass plant, the dark *teliospores* (III), which infect nothing but remain on straw or stubble resisting winter temperatures, and germinate in the spring to produce the *basidiospores* (IV) which carry rust to barberry, infect it, germinate, and produce *pycniospores* (0), which fuse sexually to produce *aeciospores* (I), which blow to and infect the grass plant to complete the life cycle. See (8) Rust under General Diseases.

Sanitation — Keeping the garden clean. Destroying all infested and infected plant parts during the season. Removing and composting or burning all plant tops in the fall, together with surrounding weeds. Often the most important part of disease control. See Section 3.

Saprophyte — An organism that feeds on dead organic matter, as opposed to a para-

site which feeds on living tissue. See Parasite.

Sapwood — The outer part of xylem tissue in a woody stem.

Scab — A roughened, crustlike, diseased area (lesion) on the surface of a plant part. Also the disease in which scab is a symptom. See (14) Scab under General Diseases.

Scaffold branches — The primary branches of a tree which arise from the trunk.

Scion — A piece of twig or shoot inserted on another in grafting.

Sclerotium (pl. sclerotia) — A small, compact, fungus resting body composed of an interwoven mass of mycelial threads with a hard outer rind. Sclerotia are generally dark colored, more or less round or flat, and vary greatly in size. Sclerotia may remain viable in the soil, in plant refuse, or in seeds for many years and are capable of germinating or bearing fruiting bodies which infect new plants under favorable conditions of temperature and moisture.

Scorch — "Burning" of plant tissue from infection, lack or excess of some nutrient, or weather conditions. Often appears as dead areas along the margins and tips of leaves.

Secondary infection — Infection resulting from the spread of infectious material which has been produced following a primary infection (the first infection by a disease-producing organism after a resting period) or from other secondary infections without an intervening inactive period.

Seed disinfectant or disinfectant — A chemical that destroys certain disease-causing organisms carried in (disinfectant) or on (disinfectant or disinfectant) the seed. They are not necessarily seed protectants.

Seed protectant — A chemical applied to seed before planting to prevent seed decay and damping-off. See pages 427-36.

Semesan — Contains hydroxymercurichlorophenol. A dust seed disinfectant for vegetable and flower seed or a pink powder (Semesan Bel) used for potato and sweet-potato seed treatment; also used as a soil drench and a turf fungicide (Semesan Turf Fungicide). See tables 13 and 14 in the Appendix.

Sexual propagation — To increase plant numbers by seed.

Shade tolerant — Plants that can grow on reduced sunlight.

Shoot — A leafy stem of current season's growth.

Shot-hole — A symptom of disease in which small diseased fragments of leaves drop out leaving small holes making them look as if riddled by shot. See (4) Shot-hole under General Diseases.

Side-dressing — Fertilizer applied to the side of a row crop during growth. Often below the soil surface.

Sign — Evidence of disease indicated by the presence of disease-causing organisms or of any of their parts and products (e.g., spores, mycelium, exudate, fruiting bodies of the pathogen).

Slime flux or Wetwood — Found on certain trees which bleed freely when wounded and sometimes forced out of previously unwounded bark by pressure in the vascular system. Slime flux of elm is known to be caused by bacteria.

Slime mold — Primitive fungi whose plasmodia "flow" over low-lying vegetation like an amoeba. Found commonly on lawns, strawberry beds, seed beds, rotting logs, and tree trunks. The fruiting stage is powdery. See under Lawnglass.

Slip — A herbaceous or softwood cutting.

Slurry — A thick suspension of a finely divided material in a liquid. A common method of commercial seed treatment.

Smut — A disease caused by a smut fungus, or the fungus itself. Characterized by resting spores (chlamydospores), which generally accumulate in black, powdery masses (sori). The black spore masses may break up into a fine dustlike powder readily scattered by the wind or remain firm and more or less covered. See (11) Smut and (13) White Smut under General Diseases.

Soil conditioners — Chemicals which aggregate soil particles for improved soil structure.

Soil Drench C — A liquid soil fungicide containing 2.2 per cent methyl mercury di-cyandiamide.

Soil Fumigant M — See Table 14 in the Appendix.

Soilfume — See Table 14 in the Appendix.

Soil-less culture — Also called hydroponics. The growing of plants in nutrient solution without soil.

Soil sterilization — Treating soil by heat or chemicals as to kill living organisms in it. See pages 437-44 in the Appendix.

Solanaceous — Plants in a family which include potato, tomato, eggplant, pepper, tobacco, and Chinese lanternplant.

Sooty molds — Fungi with dark hyphae which live in the honeydew secreted by aphids, mealybugs, scales, and whiteflies, which forms a sooty coating on the foliage. See (12) Sooty Mold under General Diseases.

Sorus (pl. sori) — A compact mass of spores produced in, or on, the host plant by fungi such as the rusts and smuts.

Southern blight — See Crown rot.

Spathe — A large bract or pair of bracts sheathing a flower cluster (e.g., Jack-in-the-pulpit).

Species — Any one kind of life subordinate to a genus but above a race, strain, or variety. See Genus and also Race.

Sperton — See Table 1.

spore — A part of a fungus corresponding to

the seed of higher plants. A microscopic, one- to many-celled body serving to reproduce and disseminate a fungus. Spores may be either nonsexual (asexual), formed directly from vegetative hyphae, but often in special fruiting structures; or sexual, formed from a union of two cells representing a difference in sex. See Figure 3. Some, called resting spores, have thick walls that enable them to survive unfavorable growing conditions. Some spores are very light and can be blown hundreds of miles by the wind. Others are transported easily by water, insects, animals, man, and machinery. When conditions are favorable, the spore germinates to produce a hyphal tube which later develops into a new fungus body.

Sporophore — A stalklike structure on which spores are borne.

Sporulate — To form spores.

Spot — A definite, localized, diseased area. See (1) Fungus Leaf Spot and (2) Bacterial Spot under General Diseases.

Spotrete — A lawn fungicide containing thiram.

Spreaders and stickers — Materials used to reduce surface tension and retain a uniform deposit of pesticide on plant surfaces and to make them adhere for a longer period of time. Some common *spreaders* are Santomerse, Tween-20, soap, and detergent. Common materials used primarily for their sticking qualities are the following: casein, powdered skim milk, wheat flour, soybean flour, and fish oils. Some commercial *spreader-stickers* include: Triton B-1956, Sterex, Ortho Spreader-Sticker, Nu-Film, X-77 Spreader-Activator, Filmfast, and Spread-Rite. See also page 104.

Spur — A short, woody stem (branch). The principal fruiting area of many fruit trees.

Staghead — Dying of a tree from the top downward. Characteristic of certain diseases (e.g., oak wilt on white and bur oaks).

Staminate flower — One that has stamens (male parts) but no pistils (female parts).

Starter solution — Fertilizer (possibly also containing pesticides) dissolved in water and applied immediately following transplanting. See also page 19.

Stele — The central cylinder in the stems and roots of vascular plants.

Sterilant — Any agent or chemical that destroys all living organisms in a substance (e.g., soil). See Table 14 in the Appendix.

Sterilization (soil) — Use of steam or chemicals to prevent disease, insect, nematode, or weed problems. Often better called pasteurization.

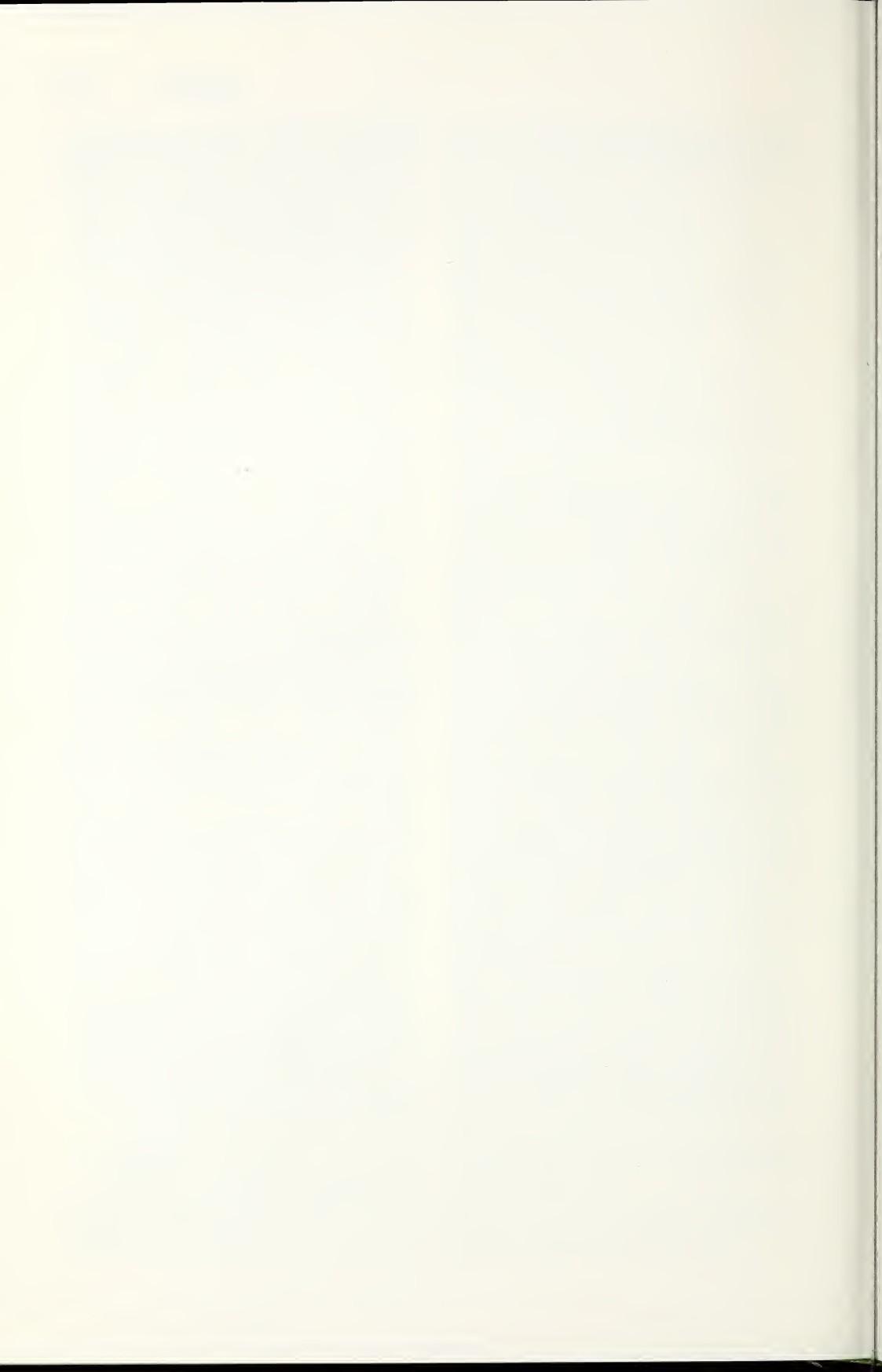
Stickers — See Spreaders and page 104.

Stock — The root or stem on which a graft is made.

Stolon (runner) — A creeping, trailing, horizontal stem or runner which may produce

- roots or new stems from nodes and become an independent plant.
- Stoma** (pl. *stomata*) — A minute pore opening in the leaf or stem of plants, utilized in the exchange of gases for respiration, photosynthesis, and transpiration. Many disease-producing microorganisms enter plants through pores. See Figure 3.
- Strain** — An organism or group of organisms (or virus) which differs in origin or minor aspects from other organisms of the same species or variety. See Race. Also a special type of plant selected from a variety.
- Streptomycin formulation** — Contains a n antibacterial antibiotic. Available as powders or liquids to control various bacterial diseases of plants. See page 88.
- Stunted** — An unthrifty plant reduced in size and vigor due to unfavorable environmental conditions. May be due to a wide range of parasitic and nonparasitic agents.
- Substrate** — The material or substance on which a saprophytic organism feeds and develops.
- Succulent** — Watery (e.g., stems and leaves high in water content). Also refers to a group of ornamental plants with thick, fleshy leaves and high in water content.
- Sucker** — A shoot arising from a root.
- Sulfur** — Used as a dust or spray to control many foliage diseases (e.g., powdery mildews and brown rot of stone fruits). Dusting sulfur is finely divided (325 mesh or finer). Wettable sulfur is a finely divided elemental sulfur with a wetting agent added.
- Sunox** — See Oxyquinoline sulfate.
- Sunscauld** — Plant tissues burned or scorched by too much sun and other unfavorable conditions.
- Suspect** — Usually a more precise term for host. Any living organism liable to infection by a given disease-producing agent. See Host.
- Susceptibility** — Lacking inherent ability to resist disease or attack by a pathogen.
- Symbiosis** — A mutually beneficial association of two or more organisms (e.g., powdery mildew fungus and mite = witches'-broom of hackberry).
- Symptoms** — External or internal expressions of plant disease produced by the plant. Symptoms may be:
- (a) **necrotic** — disease resulting in death of tissues. Results in formation of blights, damping-off, wilt, or rots.
 - (b) **hypoplastic** — underdevelopment in size or number of plant organs. May result in chlorosis, mosaic, mottling, yellows, or dwarfing.
 - (c) **hyperplastic** — overgrowth in size or number of plant organs. Results in formation of galls, witches'-brooms, scab, callus growth, or curl.
- Synergist** — Any substance that increases the toxic effects of a pesticide.
- Systemic** — Applies (1) to a disease in which the pathogen (or a single infection) spreads generally throughout the plant body and (2) to chemicals which spread through a plant internally.
- Telone** — See Table 14 in the Appendix.
- Tenacity** — The tendency of a deposit to resist removal by weathering.
- Tendril** (rust) — Slender, leafless organs which serve a climbing plant (e.g., pea, grape) as a means of attachment. Also the spore "horns" of certain cedar-rust fungi.
- Terminal** — The end of a shoot, twig, or branch.
- Terraclor** — See PCNB.
- Tersan OM** — A multipurpose turf fungicide containing 45 per cent thiram and 10 per cent hydroxymercurichlorophenol.
- Thimer** — A multipurpose turf fungicide containing 75 per cent thiram and 3 per cent phenyl mercury acetate.
- Thiram** — Tetramethyl thiuram disulfide (TMTD). A pink, green, or white powder (or dust) used in seed and bulb treatment, and as a spray or soil drench on tree seedlings, turf, fruit, ornamentals, and vegetables. See tables 1, 13, and 14 in the Appendix.
- Thylate** — A fungicide containing 65 per cent thiram. Used for the control of diseases of ornamentals, apples, strawberries, and other plants.
- Tissue** — A group of cells of similar structure which perform a special function.
- Tissue test** — Determination of plant food needs by a chemical analysis of leaves or stems.
- Toadstool** — See Mushroom.
- Tolerance (tolerant)** — The degree of endurance of a plant to the effects of adverse conditions, chemicals, or parasites. A tolerant plant is capable of sustaining a disease without serious injury or crop loss. Also refers to the amount of toxic residue allowable in or on edible plant parts under the law. See Pesticide tolerance.
- Topworking** — Changing the variety (or varieties) of a tree by inserting buds or grafts on its branches.
- Toxin** — A poison produced by an organism.
- Trade names** — Names given to company products to distinguish them from similar competitive products. See tables 1 and 14.
- Translocation** — The movement of water, minerals, and food within a plant.
- Transpiration** — The loss of water by evaporation from a plant. Occurs largely from internal leaf surfaces.
- Tree surgery** — The art of removing large limbs, cleaning and treating of wounds, cabling and bracing weak trunks, crotches, and branches.
- Triton B-1956** — See Spreaders and stickers.
- Tuber** — A short, fleshy, much enlarged, underground stem (e.g., Irish potato).

- Turf** — Grass used for a lawn.
- Twig** — One-year-old stem or branch of a woody plant.
- Tylosis** (pl. *tyloses*) — A cell outgrowth into the cavity of a xylem vessel, plugging it. Important in certain wilt diseases of woody plants (e.g., Dutch elm disease and oak wilt).
- Vapam** — See Table 14 in the Appendix.
- Variegation** — A general term for discoloration of foliage or flowers from genetic causes — not from virus infection.
- Variety** — A group of closely related plants of common origin that differ from each other in certain details such as form, color, flower, and fruit. Special types are selected from the variety and are called strains.
- Vascular** — Refers to plant tissues that conduct fluids. See Xylem and Phloem.
- V-C 13 Nemacide** — See Table 14 in the Appendix.
- Vector** — An agent that transmits a pathogen (e.g., man, insects, mites, birds).
- Vegetative** — Nonsexual. Also refers to a significant increase in size.
- Vein banding** — A symptom of a virus disease in which the areas along the leaf veins are darker green than the tissue between the veins.
- Verticillium wilt** — A widespread, systemic, vascular disease which attacks hundreds of different kinds of plants. See (15B) Verticillium Wilt under General Diseases.
- Viability** — State of being alive (e.g., ability of seeds to germinate).
- Vidden D** — See Table 14 in the Appendix.
- Virulent** — Strong ability to produce disease. Highly pathogenic.
- Viruliferous** — Containing or carrying a virus. Usually pertains to an insect which carries a virus and can infect a plant with it.
- Virus** — Submicroscopic, filterable, infectious agents (bodies) too small to be seen with a compound microscope. Viruses have characteristics of both living and nonliving matter. They are large, high molecular weight proteins capable of multiplying and acting like living organisms when they are in living plant and animal tissues. Recognizable by the symptoms they produce in infected hosts. See page 10.
- V.P.M. Soil Fumigant** — See Table 14 in the Appendix.
- Water-logged** — Without soil aeration due to a lack of or poor soil drainage.
- Watersprouts** — Rapidly growing shoots arising from adventitious or latent buds on the trunk or branches.
- Weed** — Any unwanted plant.
- Well-drained soil** — Draining out of all excess moisture from a soil. May occur naturally or through the aid of agricultural drain tile, lightening with peatmoss and sand or gravel. See page 25.
- Well-prepared soil** — A soil which has ample organic matter and plant nutrients, which has been well mixed to remove large rocks and objectionable plant debris to give maximum facilities for good plant growth.
- Wettable powder** — One that is easily wetted by water and will go into suspension.
- Wetwood** — See Slime flux.
- Wilt** — The lack of freshness and drooping of leaves due to lack of water (inadequate water supply or excessive transpiration); or to a vascular disease which interrupts the normal uptake and distribution of water by a plant or to a toxin produced by an organism. See (15) Wilts under General Diseases.
- Witches'-broom** — A symptom of disease where an abnormal brushlike development of many weak shoots arises at or close to the same point. Hackberry trees are commonly affected with this disease. May be caused by fungi, mites, viruses, and bacteria.
- Woodridge Mixture "21"** — A turf fungicide containing 66.7 per cent calomel and 33.3 per cent corrosive sublimate.
- Wood Tox** — See Pentachlorophenol.
- Woody** — Hard, tough, and fibrous. Nonherbaceous.
- Xylem** — The complex conducting tissue in plants by which water and minerals move up the stem from the roots to the leaves. Furnishes mechanical support for the plant.
- Yellows** — A disease (caused by a fungus, virus, bacterium, or a deficiency of one or more essential elements) characterized by yellowing and stunting of affected parts.
- Zineb** — Zinc ethylene bisdithiocarbamate. A wettable powder used as a spray for the control of vegetable, fruit, flower, turf, tree, and shrub diseases. Also used as a dust and soil drench. See tables 1, 10, 13, and 14 in the Appendix.
- Ziram** — Zinc dimethyl dithiocarbamate. A wettable powder used as a spray for control of vegetable diseases especially in the seedling stage. Also used to control certain foliage diseases of ornamentals, trees, and shrubs. Often used as a dust and soil drench. See Table 1.



Index

Illustrations are indicated by page numbers in brackets, thus: [233].

- Aarons-rod; *see Thermopsis*
Aaronsbeard; *see St.-Johns-wort*
Abelia, 371
chlorosis, 16, 285, 372
leaf spot, 33, 371
powdery mildew, 41, 372
root-knot, 75, 323, 372
root rot, 73, 372
Abies, 330
Abronia, 227
Abrus, 311
Abutilon, 246
infectious chlorosis, 247
leaf blight, 35, 246
leaf spot, 33, 246
mosaic, 57, 247
root-knot, 75, 247
root nematode, 247
root rot, 73, 247
rust, 44, 246
stem rot, 62, 63, 247
verticillium wilt, 53, 141, 247
virus-infected, 11
Acacia, 248
canker, dieback, 63, 248
chlorosis, 16, 248, 285
leaf spot, 33, 249, 286
mistletoe, 79, 249
powdery mildew, 41, 248
root-knot, 75, 248, 323
root rot, 73, 117, 248
rust, 44, 249
wood rot, 64, 142, 248
witches'-broom, rust, 44, 249
Acalyptha, 108
downy mildew, 40, 108
leaf spot, 33, 108
oedema, 28, 108
powdery mildew, 41, 108
red leaf gall, 108
root-knot, 75, 108
root nematode, 108
root rot, 73, 108
Acanthopanax, 108
leaf spot, 33, 108
root rot, 73, 108
rust, 44, 109
verticillium wilt, 53, 108
Acer, 284
Achillea, 181
crown gall, 68, 186
powdery mildew, 41, 183
root-knot, 75, 184, 185
root rot, 73, 183
rust, 44, 184
stem rot, 62, 156, 183
Achlys, 129
Acidanthera, 232
Acidity, excess, 16
Acme Bordeaux Mixture, 88
Acme Garden Fungicide, 447
Acme Quality Paints, Incorporated, 104
Aconite, 208
bacterial leaf spot, black blotch, 33, 209
leaf and stem smut, 47, 210
mosaic, 57, 209
powdery mildew, 41, 209
root-knot, 75, 209
root rot, 73, 208
rust, 43, 44, 210
soil drench, 208, 209
stem or crown rot, 62, 208
verticillium wilt, 53, 209
Aconitum, 208; *see also Aconite*
mosaic, 57, 209
rust, 44, 210
smut, 47, 210
verticillium wilt, 53, 209
Actaea, 112
Acti-dione
formulations, 89
injury, 30
trade names and distributors, 89
uses, 89
wound treatment, 317
Acti-dione-thiram, 266, 267
Actinomeris, 181
Adam-and-Eve; *see Erythronium*
Adams-needle; *see Yucca*
Adderstongue; *see Erythronium*
Adiantum, 223
Aesculus, 250
Aethionema, 154
African daisy; *see Arctotis, Gazania*
African forget-me-not; *see Anchusa*
African-lily, 399; *see also Tulip*
mosaic, 57, 401
African-violet, 109
botrytis blight, 37, 70, 109
bud drop, 110
chlorosis, leaf scorch, 16, 28, 110
crown and stem rot, [62], 109
flower blight, 70, 109
leaf nematode, 61, 110
light requirements of, 28
mosaic, 57, 110
petiole rot, 111
plant soak, 110, 429, 433
powdery mildew, 41, [110]
ringspot, 110
root-knot, 75, 110
root nematode, 109
root rot, 73, 109
Agapanthus, 399
Agave, 178
Ageratum, 181
powdery mildew, 41, 183
root rot, 73, 183
rust, 44, 184
southern blight, 62, 183
stem rot, 62, 183
Aglaonema, 162
Agri-mycin, 89
Agri-mycin 500, 89
Agri-mycin 100, 89, 322
Agricultural drain tile; *see Tile, agricultural drain*
Agropyron, 265
Agrostemma, 169
Agrostis, 265
Ailanthus, 398
Air humidity, 28
Air pollution, 29
Air potato; *see Yam*
Ajuga, 111
crown rot, 62, 111
root-knot, 75, 111
southern blight, 62, 111
Albizia, 248
Alcohol
as disinfectant, 55, 64, 66, 70, 83
seed treatment, 67
Alder, 142
canker, dieback, 63, 143
gray-mold (leaves), 37, 142
leaf blister or curl, 47, 142
leaf spot, 33, 142
mistletoe, 79, 143
powdery mildew, 41, 143
root-knot, 75, 143
rust, 44, 142
sooty mold, 48, 143
witches'-broom, 47, 143
wood rot, 64, 142
Aldrin, 53, 68, 83
Alkali injury, 16, 17
Alkanet; *see Anchusa*
Allionia, 227
Allium, 299; *see also Onion*
bulb rot, 75, 299
leaf blight, 35, 300, 302
leaf spot, 33, 302
mosaic, 55, 301
rust, 44, 302
yellow, 58, 301, 302
Allyl alcohol, 89, 443

- Almond, 315; *see also* Flowering almond
anthracnose, 35, 323
asteroid spot, 321
bacterial leaf spot, 33, 318
bacterial shoot blight, 33, 66, 318
blossom blight, 66, 70, 315
brown rot, 70, 315
chlorosis, 16–18, 285, 323, 407
coryneum blight, 37, 63, 322
crown gall, 68, 322
crown rot or canker, 62, 117, 323
dieback, 63, 315, 322
fire blight, 66, 70, 114, 324
fruit spot or rot, 70, 315, 318, 323
gray-mold, 37, 323
leaf blight, 35, 323
leaf curl, 47, 316
leaf spot, 33, 323
little leaf, 17, 323, 407
mosaic, 57, 320
peach yellows, 58, 319
phony peach, 320
powdery mildew, 41, 322
ringspot, 57, 320
root-knot, 75, 323
root nematode, 323
root rot, 73, 117, 323
rosette, 58, 319
rust, 44, 322
scab, 50, 70, 318
shot-hole, 37, 318, 322, 323
spray schedule, 424–425
thread blight, 324, 409
verticillium wilt, 53, 322
wood rot, 64, 142, 316
X-disease, 318
- Alnus*, 142
- Aloe*, 111
plant soak, 111, 429, 433
root rot, 73, 111
- Alpine currant*; *see* Flowering currant
- Alternanthera*, 189
fusarium wilt, 53, 184, 189
leaf blight or spot, 33, 35, 181, 189
root-knot, 75, 189
root rot, 73, 189
white-rust, 47, 186, 189
- Althaea*, 246
- Aluminum foil, as tree wrap, [29]
- Aluminum sulfate, 16
- Aluminum toxicity, 16
- Alumroot; *see* *Heuchera*
- Alyssum*, 155; *see also* Sweet alyssum
aster yellows, 58, 160
clubroot, 73, 156
curl-top, 60, 159
damping-off, 62, 156
downy mildew, 39, 157
stem rot, 62, 158
white-rust, 47, 158
- Amaranth*, 189
aster yellows, 58, 136, 189
blossom blight, 70, 189
curl-top, 60, 136, 189
damping-off, seed rot, 62, 189
leaf blight or spot, 33, 35, 181, 189
- leaf roll, 189, 341
mosaic, 57
root-knot, 75, 189
root nematode, 189
root rot, 73, 189
white-rust, 47, 186, 189
- Amaranthus*, 189
- Amaryllis*, 204; *see* *Lycoris* for Hardy amaryllis
bulb rot, 75, 204
bulb soak, 205, 428, 433
gray-mold blight, 37, 205
leaf scorch or red blotch, 36, 205
leaf spot, 33, 207
mosaic, [56], 57, 205
root nematode, 205, 207
root rot, 73, 204
southern blight, 62, 204
spotted wilt, 57, 207
- Amazon-lily*, 204
gray-mold blight, 37, 205
leaf scorch or red spot, 36, 205
mosaic, 57, 205
- Amelanchier*, 114; *see also* Apple
black mildew, witches'-broom, 47, 48, 120
blossom blight, 70, 114
canker, dieback, 63, 118
fire blight, 66, 116
fruit rot, 70, 118
leaf blight, 36, 120
leaf blister, witches'-broom, 47, 122
leaf spot, 33, 120
powdery mildew, 41, 117
root rot, 73, 117
rust, 43, 44, 116
wood rot, 64, 119
- American bladdernut*, 112
leaf spot, 33, 112
sooty blotch, 48, 112
twig blight, 63, 112
- American cowslip*; *see* Shoot-ingstar
- American Cyanamid Company*, 104
- American spikenard*, 108
leaf spot, 33, 108
rust, 44, 109
verticillium wilt, 53, 108
- American or true mistletooe*, 78, [79]
- Amitrol* injury, 30
- Ammate*, 295
- Amoban*, 447
- Amorpha*, 222; *see also* Indigo-bush
powdery mildew, 41, 222
rust, 44, 222
twig canker, 63, 222
- Ampelopsis*, 232; *see also* Grape canker, dieback, 63, 240
downy mildew, 40, 237
leaf spot, 33, 237, 240
powdery mildew, 41, 238
root rot, 73, 117, 239
rust, 44, 240
thread blight, 240, 409
- Amsonia*, 405
leaf spot, 33, 405
rust, 43, 44, 405
- Anagallis*, 314
aster yellows, 58, 344
leaf spot, 33, 344
root-knot, 75, 345
- Anaphalis*, 181
- Anchusa*, 288
aster yellows, 58, 288
curl-top, 60, 288
damping-off, 62, 288
mosaic, 55, 288
powdery mildew, 41, 288
rust, 44, 288
- Andromeda*, 112
leaf spot, 33, 112
root nematode, 112
root rot, dieback, 73, 112
tar spot, 33, 112
- Androsace*, 344
- Anemone*, 112
aster yellows, 58, 113
blossom blight, 70, 113
botrytis collar rot, 37, 62, 113
crown rot, 62, 113
downy mildew, 40, 113
flower breaking, 57, 113
leaf gall, spot disease, 33, 113
leaf spot, 33, 112
leaf and stem nematode, 61, 113
leaf and stem smut, 47, [113]
mosaic, 57, 113
powdery mildew, 41, 113
rhizome rot, 62, 113
rust, 43, 44, 112
southern blight, 62, 113
spotted wilt, 57, 113
white smut, 50, 113
- Anemonella*, 112
- Anethum*, 175
- Angelica*, 114
leaf spot, 33, 114
root rot, 73, 114
rust, 44, 114
- Angels-trumpet*; *see* *Datura*
- Angraecum*, 302
- Anise*, 175
aster yellows, 59, 172, 176
leaf spot, 33, 175
root rot, 73, 177
rust, 44, 177
seed rot, damping-off, 62, 176
seed treatment, 176, 431
stem rot, 62, 172, 176
- Anise-root*, 175; *see also* Sweet-jarvil
rust, 44, 177
seed rot, damping-off, 62, 176
seed treatment, 176
- Anisetre*, 283; *see also* Mag-nolia
algal leaf spot, 283
black mildew, 48, 283
sooty mold, 43, 283
- Annual aster*; *see* *China-aster*
- Annual blanket-flower*; *see* *Gail-lardia*
- Anoda*, 246
powdery mildew, 41, 247
rust, 44, 246
- Antennaria*, 181; *see also* Ever-lasting
white-rust, 47, 186
- Anthemis*, 181
- Anther* smut, 47
- Anthony waterer*; *see* *Spirea*

- Anthracnose, 33, 35-37, [36], [63]
Anthriscus, 175
Anthurium, 162
 anthracnose, 35, 163
 leaf spot, 33, 163
 root nematode, 162
Antibiotics, to control plant disease, 88
Anticarie, 80, 299
Antirrhinum, 368
Antrol Garden Products, Boyle-Midway, 104
Aphids, 11
 control, 57, 60, 83
 secretion of "honeydew," 48
 as virus carriers, 11, 57, 58, 60, 83
Apple, 175
Apple, 114
 anthracnose, 36, 120
 bacterial blast, 33, 114
 baldwin spot, 120
 bitter pit, 120
 bitter rot, [72], 118
 black end, 120
 black rot, 33, 63, 70, 116
 blossom blight, 66, 70, 114
 blotch, 33, 63, 70, [116], 117
 boron deficiency, 17, 18, 121
 brown core or heart, 120
 canker, 63, [118]
 collar rot, 62, 119
 crown gall, 68, [69], 117
 dieback, 63, 116, 118
 felt fungus, 122, 241
 fire blight, [65], 66, 114
 flat limb, 121
 fly speck, 70, 117
 fruit breakdown, 120
 fruit rot, 68, [72], 118
 fruit spot, 70, 118
 gray-mold rot (*Botrytis*), 37, 118
 hairy root, 68, 117
 internal cork, 121
 jonathan spot, 120
 leaf blight, 36, 120
 leaf scorch, 28, 121
 leaf spot, 33, 120
 limb blight, 63, 118
 little leaf, 121
 mistletoe, [79], 121
 mosaic, 57, 121
 powdery mildew, 41, 117
 pruning, 21
 root nematode, 121
 root rot, 73, 117
 rubbery wood, 121
 rust, 43, [44], 116
 scab, 50, [51], 70, 115
 scald, 120
 soggy breakdown, 120
 sooty mold, 48, [49], 117
 spray schedule, 424-25
 sunscald, 28, 119
 thread blight, 122, 409
 twig canker, 63, [118]
 watercore, 120
 winter injury, 28, [119]
 wood rot, 64, 119
 woolly knot, 117
 zinc deficiency, 17, 121
Apple-of-Peru, 389
 leaf spot, 33, 390
 mosaic, 57, 392
 ringspot, 57, 394
 root rot, 73, 396
 spotted wilt, 57, 393
 streak, 392
Application equivalents, 418
Apricot, 315
 asteroid spot, 321
 bacterial canker, gummosis, 66, 318
 bacterial leaf spot, 33, 318
 black knot, 66, 317
 blossom blight, 66, 70, 315
 brown rot, 70, 315
 canker, 63, 315, 318, 322
 chlorosis, 16-18, 285, 323, 407
 coryneum blight, 36, 63, 322
 crown gall, 68, 322
 dieback, 63, 315, 322
 felt fungus, 241, 324
 fire blight, 66, 70, 114, 324
 fruit spot or rot, 37, 70, 315, 318, 323
 leaf curl, 47, 316
 leaf spot, 33, 323
 little leaf, 17, 323, 407
 little-peach, 319
 mosaic, 57, 320
 peach yellows, 59, 319
 phony peach, 320
 powdery mildew, 41, 322
 ring pox, 57, 321
 ringspot, 57, 320
 root-knot, 75, 323
 root nematode, 323
 root rot, 73, 117, 323
 rosette, 59, 319
 rust, 44, 322
 scab, 50, 70, 318
 shot-hole, 37, 318, 322, 323
 spray schedule, 424-25
 twig blight, 63, 315, 322
 verticillium wilt, 53, 322
 wood rot, 64, 142, 316
 X-disease, 318
Aquilegia, 208
Arabian-tea, 143
 leaf tip blight, 35, 144
Arabis, 155
Arachis, 324
Aralia, 108; *see also Acanthopanax*, American spikenard, Hercules-club, Sarsparilla, Udo
 leaf spot, 33, 108
 powdery mildew, 41, 108
 rust, 44, 109
 verticillium wilt, 53, 108
Arasan 75, 87, 419, 430
 SF-M, 430
 SF-X, 430
Araucaria, 122
 branch blight, 63, 122
 crown gall, 68, 122
 dieback, 63, 122
 leaf spot, 33, 122
 root rot, 73, 122
Arborist, 22, 70
Arborvitae, 229; *see also Hiba arborvitae*
 brown felt blight, 261, 334
 canker, dieback, 63, 260
 damping-off, 62, 260, 333
 gray-mold blight, 37, 260
 leaf blight, needle cast, 36, 260
 leaf-browning and shedding, 260
 needle blight or spot, 36, 260
 nursery blight, 36, 260
 pruning, 22
 root nematode, 261, 323
 root rot, 73, 117, 260
 snow blight, 261, 334
 sooty mold, 48, 260
 twig blight, dieback, 63, 260
 winter injury, browning, 28, 260
 wood, trunk, or butt rot, 64, 142, 260
Arbutus, 145
 crown gall, 68, 146
 leaf blight or blotch, 36, 147
 leaf spot, 33, 147
 red leaf gall, spot, 47, 146
 root rot, 73, 147
 rust, 45, 146
 spot anthracnose, 36, 146
 tar spot, 33, 146
 trunk canker, 63, 147
 wood rot, 64, 142, 147
Arctostaphylos, 145
Arctotis, 181
 leaf blotch, 36, 181
 leaf spot, 33, 181
 root-knot, 75, 134, 185
 root rot, 73, 183
Arecastrum, 307
Arenaria, 169
 anther smut, 47, 171
 leaf spot, 33, 170
 powdery mildew, 41, 171
 root rot, 73, 169
 rust, 45, 169
Arenga, 307
Argemone, 338
Argyreia, 290
 root-knot, 75, 291
 root rot, 73, 291
Arisaema; *see Jack-in-the-pulpit*
Aristolochia, 123
 gray-mold blight, 37, 123
 leaf spot, 33, 123
 root rot, 73, 123
Armeria, 365
 rust, 45, 365
Armillaria root rot, [74]
Armoracia, 155
Arnica, 181
 leaf spot, 33, 181
 powdery mildew, 41, 183
 rust, 45, 184
 white smut, 50, 186
Aronia, 114
Arrowroot, 347
 leaf spot, 33, 347
 rust, 43, 347
Arrowwood, 404; *see also Viburnum*
 bacterial leaf spot, 33, 404
 canker, dieback, 63, 404, 405
 downy mildew, 40, 404
 leaf spot, 33, 404
 powdery mildew, 41, 404
 root-knot, 75, 323, 405
 root rot, 73, 117, 405
 rust, 45, 405
Arsenic injury, 30

- Artemisia, 181
 crown gall, 68, 186
 downy mildew, 40, 185
 leaf blight, 36, 37, 181
 leaf spot, 33, 181
 powdery mildew, 41, 183
 root-knot, 75, 134, 185
 root rot, 73, 183
 rust, 45, 184
 white-rust, 47, 186
- Artichoke; *see* Globe artichoke, Jerusalem-artichoke
- Artillery-plant, 123
 leaf spot, 33, 123
 powdery mildew, 41, 123
 root-knot, 75, 123
 root rot, 73, 123
- Aruncus, 356
- Asclepias, 154
- Ascorbic acid, 29
- Ascyrum, 362
- Ash, 124; *see* Hopetree for Wafer ash
 anthracnose, 36, 124
 black mildew, sooty mold, 48, 125
 canker, dieback, 63, 124
 felt fungus, 125, 241
 flower gall, 125
 hairy root, crown gall, 68, 124
 leaf scorch, 28, 124
 leaf spot, 33, 124
 mistletoe, 79, 125
 powdery mildew, 41, 125, 143
 root-knot, 75, 125, 323
 root rot, 73, 117, 125
 rust, 45, [124]
 seedling blight, 62, 125, 333
 twig blight, 63, 124
 verticillium wilt, 53, 125
 wood rot, 64, 124, 142
- Asimina, 311
- Asparagus, garden, 125
 anthracnose, 36, 125
 bacterial soft rot, 68, 126
 branchlet blight, spot, 33, 36, 125
 chlorosis, 16, 126
 crown gall, 68, 125
 damping-off, 62, 126
 fusarium wilt or yellows, 53, 125
 gray-mold blight, 37, 125
 leaf spot, 33, 125
 root and foot rot, 73, 125, 126
 root-knot, 75, 126
 root nematode, 126
 rust, 43, 45, 125
 seed treatment, 431
 stem canker, dieback, 63, 125
 stem or crown rot, 62, 126
 verticillium wilt, 53, 126
- Asparagus-bean, 311; *see also* Pea
 bacterial spot, 33, 311
 chlorosis, 16-18, 315
 leaf spot, 33, 313, 314
 mosaic, 55, 312
 pod spot, 70, 313, 314
 powdery mildew, 41, 312
- Asparagus-fern, 125; *see also* Asparagus
 anthracnose, 36, 125
 canker, dieback, 63, 125
- crown gall, 68, 125
 fusarium wilt, 53, 125
 leaf mold, 33, 125
 root or foot rot, 73, 125
 root nematode, 126
- Aspen, 337; *see also* Poplar
 canker, dieback, 63, 337
 catkin deformity, 337
 ink spot, 33, 337
 leaf blight, 35, 337
 leaf spot, 33, 337
 powdery mildew, 41, 337
 rust, 43, 337
 shoot blight, 35, 63, 337
 twig blight, 63, 337
 verticillium wilt, 53, 284, 338
 wood rot, 64, 142, 337
- Asphyxiation, 26
- Aspidistra, 126
 anthracnose, 36, 126
 chlorosis, 16, 126
 leaf blight, 36, 126
 leaf spot, 33, 126
 root rot, 73, 126
- Asplenium, 223
- Aster, perennial, 181; *see also* China-aster, Golden-aster, Stokes-aster
 crown gall, 68, 186
 damping-off, seed rot, 62, 183
 dodder, [80]
 downy mildew, 40, 185
 foliar nematode, 61, 185
 gray-mold blight, 37, [39], 185
 leaf blight or spot, 33, 36, 181
 mosaic, 57, 184
 powdery mildew, 41, 183
 ringspot, 57, 184
 root-knot, 75, 134, 185
 root nematode, 186
 rust, 45, 184
 seed treatment, 183
 spotted wilt, 57, 184
 stem canker or rot, 62, 63, 183, 185
 tar spot, 33, 181
 verticillium wilt, 53, 141, 184
 white smut, 50, 186
- Aster yellows, 58, [59]
- Astilbe, 126
 fusarium wilt, 53, 126
 powdery mildew, 41, 126
- Atamasco-lily; *see* Zephyranthes
- Athyrium, 223
- Aubretia, 155
- Aucuba, 126
 anthracnose, 36, 127
 blossom blight, 70, 127
 frost, winter injury, 28, 127
 gray-mold blight, 37, 126
 leaf spot, 33, 126
 powdery mildew, 41
 verticillium wilt, 53, 127
 wither tip, 63, 127
- Autoecious rust, 43
- Automobile injury, 30
- Autumn-crocus, 189
- Avens, 356
 aster yellows, 59, 360
 downy mildew, 40, 359
 fire blight, 66, 114, 360
 leaf smut, 47, 360
 leaf spot, 33, 358
- powdery mildew, 41, 356
 root-knot, 75, 359
 root rot, 73, 358
 rust, 45, 357
- Azocado, 127
 anthracnose, black spot, 36, 127
 bacterial blast, 33, 70
 black mildew, 48, 128
 branch canker, 63, 127
 chlorosis, 16, 128
 collar rot, 62, 127
 dieback, 63, 127
 downy mildew, 39
 flower spot, 70, 127
 fruit spot or rot, 70, 128
 leaf blight, 36, 127
 leaf spot, 33, 127
 mottle leaf, 128
 oedema, 28, 127
 powdery mildew, 41, 128
 root-knot, 75, 128
 root nematode, 128
 root rot, 73, 127
 scab, 50, 127
 seed treatment, 127, 429, 435
 seedling blight, 62, 128
 sun-blotch, 128
 trunk canker, 63, 127
 verticillium wilt, 53, 128
 wood rot, 64, 127, 142, 211
 zinc deficiency, little leaf, 17, 128
- Axonopus, 265
- Azalea, 351; *see also* Rhododendron
 anthracnose, 36, 351
 azalea kit, 353
 bud blast, 354
 chlorosis, yellow leaf, 16, 352
 crown gall, 68, 354
 crown rot or wilt, 62, 353
 cutting rot, 62, 354
 damping-off, 62, 354
 flower gall, 47, 354
 flower spot or blight, 70, [353]
 gray-mold blight, 37, 351
Growing Azaleas and Rhododendrons, 352
- leaf scorch, angular leaf spot, 36, 351
 leaf spot, 33, 351
 leaf and stem gall, "rose-bloom," 47, 354
 light, requirements of, 27
 limp blight, 70, [353]
 powdery mildew, 41, 354
 root-knot, 75, 353
 root nematode, 353
 root rot, wilt, 73, 353
 rust, 43, 45, 354
 shoot blight, 36, 351
 soil mixture for, 16
 sooty mold, 48, 354
 stem rot, 62, 353
 tar spot, 33, 351
 thread blight, 354, 409
 twig blight, 63, 353, 354
 verticillium wilt, 53, 284, 354
 winter injury, 28, 352
- Azara, 128
 stem rot, 62, 128
- Aztec lily; *see* Tigerflower

B

Babiana, 254; *see also Iris*

crown gall, 68, [69]

fire blight, [65], 66

flagella, [8], 9

gummosis, 66

hairy root, 68

leaf blotch, [35]

leaf spot, 9, 33, [35]

mosaic, 57, 255

root gall, 68

shoot blight, 66

soft rot, 9, [67]

stem rot, 67

wilt, 9, 51, [55]

Baby-blue-eyes; *see Nemophila*

Babsbreath, 169; *see also Carnation*

aster yellows, 59, 170

damping-off, 62, 169

fasciation, 67, 171

gray-mold blight, 37, 170

root-knot, 75, 171

root rot, 73, 169

root and stem gall, 68, 171

rust, 45, 169

Babytears vine, 129

leaf spot, 33, 129

powdery mildew, 41, 129

rust, 45, 129

Bachelors-button, 181; *see also Centaurea*

aster yellows, 59, 183

downy mildew, 40, 185

fusarium wilt, 53, 184

powdery mildew, 41, 183

rust, 45, 184

verticillium wilt, 53, 141, 184

white-rust, 47, 186

Bacteria, [8], 9

diseases caused by, 9

blackleg, 67

blight, 9, 33, [35], 55

brown rot, 55

bud rot, 33

canker, 9, 66

collar rot, 67

Bacterial blight, 33, [35]

canker, 66

leaf spot, 33, [35]

root gall, 68

shoot blight, 66

soft rot, [67]

stem rot, 67

wilt, [55]

Baldcypress, 330

felt fungus, 241, 334

root rot, 73, 117, 333

twig blight, 63, 330

wood rot, 64, 142, 330

Balloonflower, 140

blight, 36, 140

root rot, 73, 140

Balm, 362

leaf spot, 33, 362

Balm-of-Gilead; *see Poplar*

Balsam, garden, 129

anthracnose, 35, 129

bacterial wilt, 55, 129

damping-off, 62, 129

downy mildew, 39, 129

leaf spot, 33, 129

root-knot, 75, 129

root rot, 73, 129

rust, 43, 129

stem rot, 62, 129

verticillium wilt, 53, 129

Balsam-apple, 196

anthracnose, 36, 196

downy mildew, 40, 199

leaf blight, 36, 197

powdery mildew, 41, 199

root-knot, 75, 200

Balsam-pear; *see Balsam-apple*

Balsamorhiza, 181

Balsamroot, 181

leaf gall nematode, 61, 185

leaf spot, 33, 181

powdery mildew, 41, 183

rust, 45, 184

Baltic ivy; *see Ivy*

Baneberry, 112

leaf spot, 33, 112

rust, 45, 112

smut, 47, 113

Baptisia, 222

Barberry, 129

anthracnose, 36, 130

bacterial leaf spot, 33, 130

canker, 63, 131

damping-off, 62

dieback, 63, 131

gray-mold blight, blossom

blight, fruit rot, 37, 70,

131

leaf spot, 33, 130

mosaic, 57, 131

powdery mildew, 41, 130

root-knot, 75, 130

root nematode, 131

root rot, 73, 130

rust, 43, 45, [130]

twig blight, 63, 130

verticillium wilt, 53, 129

wood or heart rot, 64, 131

Barco Manufacturing Company,

Incorporated, 104

Barrel cactus; *see Cactus, Echinocactus*

Barrel sprayer, 95

Bas-Cop, 88

Basic Copper Fungicide, 88

Basil; *see Basilweed, Ocimum*

Basilweed, 362

leaf spot, 33, 362

rust, 43, 362

Basketflower, 181; *see also Centaurea*

aster yellows, 59, 183

powdery mildew, 41, 183

Basswood; *see Linden*

Bayberry, 410

leaf spot, 33, 410

rust, 45, 410

virus yellows, 59, 410

Beach pea; *see Sweetpea*

Beaked cornsalad; *see Cornsalad*

Beamtree; *see Mountain-ash*

Bean, garden types, 131; *see also Lima bean, Jackbean*,

Scarlet runner bean, Tepary bean

anthracnose, 36, 70, 132

ashy stem blight, 63, 133

aster yellows, 59

bacterial blight, 33, [35], 131

bacterial soft rot, 68, 70

bacterial wilt, 55, 131

baldhead or snakehead, 134

charcoal rot, 62, 133

chlorosis, 16, 135

crown gall, 68, 135

crown rot, 62, 132

curly-top, 60, 133, [134]

damping-off, 62, 133

downy mildew, 40, 133

fertilizing, 19

fusarium wilt or yellows, 53, 134

gray-mold blight, 37, 134

leaf scorch, 28, 134

leaf spot, 33, 134

mosaic, [56], 57, 131

mottle, 57, 131

pod blight or spot, 70, 134

powdery mildew, 41, 133

ringspot, 57, 135

root-knot, cyst nematode, 75, 134

root nematode, 135

root rot, 73, 132

rust, 43, [44], 45, 132

scab, 50, 134

seed rot, 133

seed treatment, 132, 133, 430, 431

southern blight, 62, 132

spotted wilt, 57, 135

stem anthracnose, 134

stem canker, 63, 132

stipple, 131

streak, 131

sunscauld, 28, 134

temperature, effect on, 28

2,4-D injury, 135, 237

verticillium wilt, 53, 134

yellow dot, 131

web blight, 134

white mold, 70, 132

Beantree, 236

Bearberry, 145; *see also Manzanita*

black mildew, 48, 147

powdery mildew, 41, 146

red leaf gall, 47, 146

rust, 45, 146

shoot gall or hypertrophy, 47, 146

Beard-tongue; *see Penstemon*

Beauty-bush, 404

leaf spot, 33, 404

Beautyberry; *see Callicarpa*

Bed-Fume, 443

Bedranch, 443

Bedstraw, 154

downy mildew, 40, 154

leaf spot, 33, 154

powdery mildew, 41, 154

root rot, 73, 117, 154

rust, 45, 141, 154

Beebalm; *see Monarda*

Beech, 135

bleeding canker, 63, 135

canker, dieback, 63, 135

felt fungus, 136, 241

leaf scorch, 28, 135

leaf spot, 33, 135, 286

mistletoe, 79, 136

- Beech (*continued*)
 mottleleaf, 135
 powdery mildew, 41, 135
 root nematode, 135
 root rot, 73, 117, 135
 sooty mold, 48, 136, 220
 verticillium wilt, 53
 wood or heart rot, 64, 135, 142
- Beet, 136
 anthracnose, 36, 138
 bacterial pocket or beet gall, 55, 139
 bacterial soft rot, 68, 139
 bacterial streak, leaf spot, 33, 138
 beet or virus yellows, 59, 137
 black root rot, 73, 136
 blackheart, 17, 137
 blackleg, 63, 137
 boron deficiency, [7], 17, 137
 cercospora leaf spot, 33, [136]
 chlorosis, 16, 17, 139
 crown gall, 68, 137
 crown rot, 62, 137
 curly-top, 60, 136
 damping-off, 62, 136
 downy mildew, 40, 138
 fertilizing, 19
 fusarium wilt, 53, 137
 gray-mold blight, 37, 138
 heart rot, [7], 17, 137
 leaf spot, rot, 33, 138
 mosaic, 57, 137
 powdery mildew, 41, 139
 ringspot, 57, 139
 root-knot, cyst nematode, 75, 138
 root nematode, 139
 root rot, 73, 136
 rust, 43, 45, 138
 savoy, 57, 137
 scab, 50, 138
 seed rot, 136
 seed treatment, 136, 431
 southern blight, 62, 138
 storage rot, 70, 138
 verticillium wilt, 53, 139
 watery soft rot, 70, 138
 web blight, 134, 138
 white-rust, 47, 138
 yellow net, 57, 137
 yellow vein, 57, 137
- Begonia, 139
 anthracnose, 36, 140
 aster yellows, 59, 140
 bacterial leaf spot or bacteriosis, 33, [35], 139
 crown gall, 68, 140
 damping-off, cutting rot, 62, 139
 flower blight, 37, 70, 139
 gray-mold blight, 37, 70, 139
 leaf nematode blight, 61, 140
 leaf spot, 33, 140
 light, effect on flowering, 27
 requirements of, 28
 low humidity, leaf scorch, 28
 mosaic, 57, 140
 oedema, corky scab, 28, 140
 plant soak, 140, 429, 433
 powdery mildew, 41, 140
 root-knot, 75, 140
 root nematode, 139
 root rot, 73, 139
- spotted wilt, 57, 140
 stem, crown rot, 62, 139
 verticillium wilt, 53, 140
- Belamcanda, 254; *see also Iris*
 bacterial leaf spot, 33, 256
 leaf spot, scorch, 33, 254
 mosaic, 57, 255
- Belladonna-lily; *see Amaryllis*
- Bellflower, 140; *see also* Balloon-flower for Chinese bell-flower
 aster yellows, 59, 141
 gray-mold blight, 37, 139, 141
 leaf spot, 33, 140
 leaf and stem nematode, 61, 141
 mosaic, 57, 110, 141
 powdery mildew, 41, 141
 root rot, 73, 140
 rust, 43, 45, 141
 southern blight, 62, 140
 stem or crown rot, 62, 140
 verticillium wilt, 53, 141
- Bellis, 181
- Bellows duster, 100
- Bells of Ireland, 362
 crown rot, 62, 208, 363
- Bellwort, 277
 leaf spot, 33, 280
 rust, 45, 279
- Beloperone, 188
- Benincasa, 196
- Bentgrass, Bent, 265; *see also* Bluegrass
 anthracnose, 36, 265
 brown patch, 267
 copper spot, 270
 cottony blight, 269
 damping-off, 62, 271
 dollar spot, [267]
 fairy ring, 268
 fusarium patch, 269
 grease spot, spot blight (*Pythium*), 269
 leaf blight, 36, 265
 leaf smut, 50, 270
 leaf spot, 33, 265
 melting-out, 265
 red thread or pink patch, 270
 root nematode, 269
 root rot, 73, 265
 rust, 45, 266
 slime mold, 267
 smut, 47, 270
 snow scald, 268
 yellow tuft (nematode), 60
- Benzoin, 127
- Berberis, 129
- Bermudagrass, 265
 brown patch, 267
 dollar spot, 267
 downy mildew, 40, 271
 fusarium patch, 269
 leaf blight, 36, 265
 leaf spot, 33, 265
 powdery mildew, 41, 266
 root nematode, 269
 root rot, 73, 265, 271
 rust, 45, 266
 slime mold, 267
 smut, 47, 270
 southern blight, 62, 265
 spot blight (*Pythium*), 269
 spring dead spot, 271
- Berry grower, 1, 3
- Berry rot, 70
- Beta, 136
- Betony; *see Stachys*
- Betula, 142
- Bichloride of mercury, 85, 427
- Bidens, 181
- Bignonia, 141
 black mildew, 48, 142
 canker, dieback, 63, 118, 142
 gray-mold blight, 37, 142
 leaf spot, 33, 141
 root-knot, 75, 142
 sooty mold, 48, 142
 spot anthracnose, 35, 141
- Bindweed; *see also California-rose*
 as virus source, 58
- Bioquin 1, 303
- Birch, 142
 anthracnose, 36, 142
 bleeding canker, 63, 143
 canker, 63, 142, 143
 dieback, 63, 142, 143
 leaf blister, 47, 142
 leaf spot, 33, 142
 mistletoe, 79, 143
 powdery mildew, 41, 143
 root rot, 73, 143
 rust, 43, 44, 45, 142
 wetwood, slime flux, 143, 218
 witches'-broom, 47, 142
 wood rot, 64, 142
- Bird-of-paradise-flower, 143
 root nematode, 143
 root rot, 73, 143
 seed rot, 143
 seed treatment, 143, 429, 433
- Birthwort, 123
- Bishopscap; *see Mitella*
- Bittersweet, 143
 canker, dieback, 63, 144
 crown gall, 68, 144
 leaf spot, 33, 144
 powdery mildew, 41, 143
 root rot, 73
- Black-alder; *see Holly*
- Black cohosh, 112
- Black-eyed-Susan; *see Rudbeckia*
- Black gum, 211; *see also* Tupelo
 canker, branch and trunk, 63, 211, 213
 mistletoe, 79, 213
 rust, 45, 213
 verticillium wilt, 53, 213, 284
 wood rot, 64, 142, 213
- Black knot, [66]
- Black locust; *see Locust*
- Black mildew, 48
- Black-salsify, 272
 aster yellows, 59, 273
 root-knot, 75, 134, 275
 white-rust, 47, 275
- Black sampson; *see Echinacea*
- Black-snakeroot, 112
- Black spot, 33, [34]
- Blackberry, 347
 anthracnose, 36, 347
 cane blight, 63, 348
 cane and crown gall, hairy root, 68, 348
 cane spot, 350
 canker, dieback, 63, 348
 collar rot, 62, 203, 350

- downy mildew, 40, 351
 dwarf, 59, 348
 fire blight, flower blight, 66,
 70, 351
 fruit rot, spot, or mold, 38,
 70, 349
 gray-mold blight, 37, 70, 349
 leaf curl, 348
 leaf spot, 33, 350
 male berry, 350
 mosaic, 57, 348
 orange rust, 43, 45, [349]
 powdery mildew, 41, 350
 root rot, 73, 117, 350
 sooty blotch, 48, 350
 spot anthracnose, 36, 347
 spray schedule, 424-25
 spur blight, 63, 348
 streak, 348
 thread blight, 351, 409
 verticillium wilt, 53, 350
 winter injury, 28, 350
 yellow or cane rust, 45, 350
- Blackberry-lily; see Belamcanda**
- Blackhawk; see Viburnum**
- Blackleg, [62]**
- Bladder-senna, 248**
 powdery mildew, 41, 248
 root rot, 73, 117, 248
 rust, 45, 249
 seedling blight, 62, 249, 333
 twig blight, 63, 248
- Bladdernut, 112**
- Blaetter-flower; see Gaillardia**
- Blazing-star; see Liatris, Mentzelia**
- Bleach, household, as disinfectant, 22, 24, 66, 83, 357**
- Blechnum, 223**
- Bleeding canker, 135, 255**
- Bleedingheart, 144**
 fusarium wilt, 53, 145
 stem or crown rot, 62, 144
- Blessed thistle; see Cnicus**
- Blight**
 bacterial shoot, 66
 blossom, 37, 70, [71]
 botrytis, 37, [39], [71]
 brown felt, 334
 cane, 63
 fire, 65, [66]
 flower, 70, [71]
 gray-mold, 37, [39], [71]
 inflorescence, 70
 leaf, 33, 35, [36], 37
 limb, 63
 needle, 35
 ray, 70, [71]
 snow, 334
 southern, 62
 stem, 62, 63
 twig, 37
 western yellow, 60
- Bloat, onion, 77, [78]**
- Bloodleaf, 189**
 inflorescence smut, 47, 189
 leaf spot, 33, 181, 189
 root-knot, 75, 189
 root rot, 73, 189
- Bloodroot, 338; see also Poppy**
 gray-mold blight, 37, 339
 leaf spot, 33, 338
 root rot, 73, 338
- Bloom spray, 424**
- Blossom blight, 37, 70, [71]**
- Blossom-end rot, [7], 73, 390**
- Blotch**
 fruit, 70
 leaf, 33, 35, [36], 37
 sooty, 48, [49]
- Blue bonnet; see Lupine**
- Blue cohosh, 129**
 leaf blight (*Botrytis*), 37, 131
 leaf spot, 33, 130
- Blue daisy, 181; see also Chrysanthemum**
 powdery mildew, 41, 183
- Blue dicks, 151**
- Blue-eyed grass, 254; see also Iris**
 leaf blight, 36, 254
 root nematode, 256
 rust, 45, 256
- Blue-eyed-Mary; see Collinsia**
- Blue laceflower, 175**
 aster yellows, 59, 172, 176
 root-knot, 75, 176
 root rot, 73, 177
 seed rot, damping-off, 62, 176
 seed treatment, 176
 stem, crown rot, 62, 176
- Blue mist spirea; see Verbena**
- Bluebeard; see Verbena**
- Bluebell of England; see Squill**
- Bluebells; see Mertensia**
- Bluebells-of-Scotland; see Bell-flower, Campanula**
- Blueberry, 145**
 anthracnose, 36, 147
 bacterial stem canker, 33, 147
 black mildew, 48, 147
 blossom blight, 70, 145, 146
 botrytis blight, 37, 70, 146
 bud gall, 148
 cane canker, dieback, 147
 chlorosis, 16, 147, 352
 crown gall, 68, 146
 fruit or berry rot, 70, 145, 147
 leaf blight, 36, 147
 leaf rust, 45, 146
 leaf spot, 33, 147
 mosaic, 55, 147
 mummy berry, 70, [145]
 powdery mildew, 41, 146
 red leaf disease, 47, 148
 red leaf gall, 47, 146
 ringspot, 57, 147
 root gall, 75, 148
 root nematode, 148
 root rot, 73, 117, 147
 rust, 43, 44, 45, 146
 shoestring, 147
 spot anthracnose, 36, 147
 spray schedule, 424-25
 stunt, 59, 146
 tar spot, 33, 147
 twig blight, 63, 145, 147
 twig canker, 63, 147
 witches'-broom, 146
 wood rot, 64, 147
- Bluegrass, 265**
 algae, green scum, 270
 anthracnose, 36, 265
 brown patch, 267
 buried debris, 271
 chemical burning, 271
 chlorosis or yellowing, 16, 17,
 271
- compaction, 271**
- damping-off or seedling blight, 62, 271**
- dog injury, 271**
- dollar spot, 267**
- fairy ring, [268]**
- fusarium blight, 270**
- fusarium patch or pink snow mold, 269**
- insect injury, 271**
- leaf blight or blotch, 36, 265**
- leaf spot, 33, [265]**
- melting-out, 265**
- mosaic, 57, 271**
- moss, 271**
- mushrooms or toadstools, 268**
- powdery mildew, 41, [266]**
- puffballs, 268**
- Pythium disease, 269**
- red thread or pink patch, 270**
- root nematode, 269**
- root rot, 73, 265**
- rust, 45, [266]**
- seed rot, 271**
- seed treatment, 271**
- slime mold, [267]**
- smut, 47, 270**
- snow scald or gray snow mold, 268, [269]**
- stem and culm rot, 62, 265**
- Bluebells; see Collinsia**
- Bluet; see Houstonia**
- Bog laurel; see Mountain-laurel**
- Bog-rosemary, rust, 43**
- Boisduvalia, 228**
 rust, 45, 228
- Boltonia, 181**
 leaf spot, 33, 181
 powdery mildew, 41, 183
 rust, 45, 184
 white leaf smut, 47, 50, 186
 white-rust, 47, 186
- Boneset; see Eupatorium**
- Bonide Pentide, 456**
- Bor-dox, 88**
- Borage, 288**
 leaf spot, 33, 181, 288
- Borago, 288**
- Bordeaux**
 dry products, 88
 injury from, 30, 88
 mixture, 88
 paint, 25, 88
 preparation of, 88
 uses, 88
- Borer, tree, control, 119, 212, 316**
- Boron**
Boron Injury to Plants, 18
 deficiency, 17-18, 409
 control of, 121, 409
 toxicity, 18
- Boston ivy, 237**
 canker, dieback, or wilt, 63, 240
- downy mildew, 40, 327**
- leaf blight, 36, 240**
- leaf spot, 33, 237**
- powdery mildew, 41, 238**
- root rot, 73, 117, 239**
- Botran, 235**
- Botrytis blight, 37-39, [38], [71]**

- Bougainvillea, 149
leaf spot, 33, 149
mosaic, 57, 149
- Boussingaultia, 282; *see also* Lythrum
root-knot, 75, 282
- Bouvardia, 149
leaf nematode, 61, 149
root-knot, 75, 149
rust, 45, 149
- Bowstring hemp; *see* Sansevieria
- Boxelder, 284; *see also* Maple
anthracnose, 36, 284
bacterial leaf spot, 33
chlorosis, 16, 285
dieback, 63, 285
felt fungus, 241, 286
leaf blight, 36, 284
leaf spot, 33, 286
powdery mildew, 41, 143, 286
root rot, 73, 117, 286
seedling blight, 62, 286, 333
sooty mold, 48, 286
tar spot, 33, 286
twig blight or canker, 63, 285
2,4-D injury, 237, 286
verticillium wilt, 53, 284
wood rot, 64, 142, 285
- Box sandmyrtle, 261
leaf gall, 47, 261
- Boxwood, Box, 150
canker, dieback, 63, 150
cutting soak, 151, 429, 435
heart or trunk rot, 64, 151
leaf blight, cast, 36, 150
leaf spot, 33, [150]
root-knot, 75, 151
root nematode, 151
root rot, 73, 151
sunscald, 28, 150
thread blight, 151, 225
twig blight, 63, 150
windburn, 28, 150
winter injury, 28, 150
- B*oyceberry, 347; *see also* Blackberry, Raspberry
anthracnose, 36, 63, 347
cane and crown gall, 68, 348
cane canker, dieback, 63, 348
downy mildew, 40, 351
fruit rot, 70, 349
gray mold of fruit, 37, 70, 349
leaf spot, 33, 350
mosaic, 57, 348
powdery mildew, 41, 350
rust, 45, 349, 350
spray schedule, 424-25
verticillium wilt, 53, 350
winter injury, 28, 350
- Brachycome, 18
aster yellows, 59, 183
- Bradson Company, 104
- Branch canker, 63
dieback, 63
- Brassica, 154
- Bridal wreath; *see* Spirea
- Broccoli, 154; *see also* Cabbage
aster yellows, 59, 160
bacterial leaf spot, 33, 158
bacterial soft rot, 68, 157
black ringspot, 57, 159
black rot, 33, 156
blackleg, 63, 155
- Clubroot, 73, 156
damping-off, 62, 155, 156, 157
downy mildew, 40, 157
drop, cottony rot, 62, 158
fusarium yellows, 53, 155
gray-mold blight, 37, 158
leaf spot, 33, 157
mosaic, 57, 159
oedema, 28, 160
root-knot, 75, 134, 158
root nematode, 160
root rot, 73, 160
- Boron deficiency, 17, 158
chlorosis, magnesium deficiency, 16, 18
- Clubroot, 73, 156
curl-top, 60, 159
damping-off, 62, 155, 156, 157
downy mildew, 40, 157
drop, cottony rot, 62, 158
fertilizing, 19
fusarium yellows, 53, 155
gray-mold blight, 37, 158
leaf mold, 33, 157
leaf spot, 33, 157
mosaic, 57, 159
oedema, 28, 160
powdery mildew, 41, 160
premature flowering, 28
root-knot, 75, 134, 158
root nematode, 160
root rot, 73, 160
seed rot, 156
seed treatment, 156, 428, 431
southern blight, 62, 158
spotted wilt, 57, 159
tipburn, 158
verticillium wilt, 53, 160
whiptail, 18, 160
white-rust, 47, 158
- Brodiaea, 151
rust, 45, 151
- Bromex, 443
- Bromofume 40, 442
Bromofume 80, 442
- Broom, 151
dieback, 63, 151
leaf blight, 36, 151
leaf spot, 33, 151
powdery mildew, 41, 151
root nematode, 151
root rot, 73, 151
rust, 45, 151
- Brother Juniper, 14, [15]
- Broussonetia, 224
- Browallia, 389; *see also* Tomato
aster yellows, 59, 394
fusarium wilt, 53, 394
root-knot, 75, 395
spotted wilt, 57, 393
white smut, 50, 397
- Brown-eyed-Susan; *see* Golden-glow
- Brown felt blight, 334
- Brown rot (bacterial), 55
- Brozone, 443
- Brush-killer, 295
- Brussels sprouts, 154; *see also* Cabbage
bacterial leaf spot, 33, 158
bacterial soft rot, 68, 157
black ringspot, 57, 159
black rot, 33, 156
blackleg, 63, 155
clubroot, 73, 156
damping-off, 62, 155, 156, 157
downy mildew, 40, 157
drop, cottony rot, 62, 158
fusarium yellows, 53, 155
gray-mold blight, 37, 158
leaf spot, 33, 157
mosaic, 57, 159
oedema, 28, 160
root-knot, 75, 134, 158
root nematode, 160
root rot, 73, 160
- seed treatment, 156, 428, 431
spotted wilt, 57
- verticillium wilt, 53, 160
- whiptail, molybdenum deficiency, 18, 160
- white-rust, 47, 158
- Bryopsis, 196; *see also* Cucurbit
bacterial spot, 33, 197
downy mildew, 40, 199
- Bryophyllum; *see* Kalanchoë
- Buchloë, 265
- Buckeye, 250; *see also* Horse-chestnut
leaf blister, 47, 142, 251
leaf blotch, 35, [250]
leaf scorch, 28, 251
leaf spot, 33, 251
mistletoe, 79, 251
powdery mildew, 41, 251
rust, 43, 251
witches'-broom, 47, 251
wood rot, 64, 142, 251
- Buckleya, rust, 43
- Buckthorn, 152
leaf spot, 33, 152
powdery mildew, 41, 152
root rot, 73, 152
rust, 43, 45, [152]
sooty mold, 48, 152
wood rot, 64, 142, 152
- Buckwheat hulls, 16
- Buckwheat-tree, 153
black mildew, 48, 153
leaf spot, 33, 153
- Bud
blast, 33, 37, 208, 210, 354
blight, 33, 37
drop, 17, 110
nematode, 12, 60, [61]
rot, 33, 37
- Budding, in transmitting viruses, 11
- Buddleia, 153
- Buffaloberry, 361
damping-off, 62, 333, 361
leaf spot, 33, 361
powdery mildew, 41, 361
root rot, 73, 117, 361
rust, 45, 361
wood rot, 64, 142, 361
- Buffalograss, 265; *see also* Blue-grass
anthracnose, 36, 265
leaf spot, 33, 265
root nematode, 269
root rot, 73, 265
rust, 45, 266
smut, 47, 270
tar spot, 33, 265
- Bugbane, 112
- Bugleweed, 111
- Bugloss; *see* Anchusa
- Bulb
diseases, 73-78
nematode, 12, 77, [78]
ring disease, 77, [78]
rot, [62], [76]
- Bulldozer injury, 30
- Bunchberry; *see* Dogwood
- Bundleflower, 151
leaf spot, 33, 151
powdery mildew, 41, 151
rust, 43, 151

Bunya-bunya, 122
Burlap strips, for wrapping trees, [29]

Bur-marigold, 181; *see also* Chrysanthemum
aster yellows, 59, 183
leaf spot, 33, 181
powdery mildew, 41, 183
root-knot, 75, 134, 185
rust, 45, 184

Burnet, 356
leaf spot, 33, 358
powdery mildew, 41, 356
rust, 45, 357

Burning-bush; *see* Euonymus, Kochia

Bush-mallow; *see* False-mallow
Bush morning glory; *see* California-rose

Bush pea; *see* Thermopsis
Bushpoppy; *see* Treepoppy
Butt rot, 64

Butter-and-eggs; *see* Toadflax

Buttercup, 208
aster yellows, 59, 183, 209
curl-top, 60, 210
downy mildew, 40, 210
gray-mold blight, 37, 208
leaf and stem nematode, 61, 210
leaf rot, 36, 209
leaf smut, white smut, 47, 50, 210
leaf spot, 33, 209
mosaic, 57, 209
powdery mildew, 41, 209
ringspot, spotted wilt, 57, 140, 209, 210
root rot, 73, 208
rust, 45, 210
stem rot, 62, 208

Butterflybush, 153
mosaic, 55, 153
pruning, 21
root-knot, 75, 153
root rot, 73, 117, 153
"scab," 153
sooty mold, 48, 153
stem or twig canker, 63, 153

Butterfly-flower, 389
anthracnose, 36, 397
aster yellows, 59, 394
blight, 36, 397
damping-off, 62, 395
fasciation or leafy gall, 67, 314, 397
leaf and stem nematode, 61, 328, 397

powdery mildew, 41, 397
root-knot, 75, 395
root rot, 73, 396
spotted wilt, 57, 393
stem or foot rot, 62, 395

Butterfly-pea, 311
leaf spot, 33, 314
root rot, 73, 312
Butterflyweed, 154
leaf spot, 33, 154, 181
mosaic, 57, 154
root rot, 73, 154, 231
rust, 45, 154

Butternut, 406; *see also* Walnut
anthracnose, 36, 406
bacterial blight, 33, 408

bunch disease, 406
canker, dieback, 63, 407
downy spot, 33, 406
leaf blight or blotch, 36, 406
leaf spot, 33, 406
nut mold, 70, 408
root-knot, 75, 409
root rot, 73, 408
sooty mold, 48, 409
trunk canker, 63, 407
wood rot, 64, 142, 408

Button snakeroot; *see* Liatris
Buttonbush, 154

leaf blight, 36, 154
leaf spot, 33, 154
powdery mildew, 41, 154
rust, 45, 141, 154
thread blight, 154, 409

Buttonwood; *see* Sycamore

Buxus, 150

C

Cabbage, 154

anthracnose, 36, 157
aster yellows, 59, 160
bacterial leaf spot, 33, 158
bacterial soft rot or stump rot, 68, 70, [157]
blackleg, 63, [155]
black ringspot, 57, 159
black rot, 33, 156
boron deficiency or brown heart, 17, 158
clubroot, 73, [75], 156
crown gall, 68, 125, 160
curl-top, 60, 159
damping-off, 62, 155, 156, 157
downy mildew, 40, 157
drop, cottony rot, 62, 70, 158
fertilizing, 19
fusarium wilt or yellows, [52], 53, 155

gray-mold blight, 37, 158
head rot, 70, 157, 158
leaf spot, 33, 157
mosaic, 57, 159
oedema, 28, 160

powdery mildew, 41, 160
root-knot, cyst nematode, 75, 134, 158
root nematode, 160

root rot, 73, 155, 160
scab, 50, 138, 160, 339
seed rot, 156

seed treatment, 156, 428, 431
seedbed treatment, 156
southern blight, 62, 158
storage rot, 70, 157, 158

temperature, effect on, 28
tipburn, 158
verticillium wilt, 53, 160

whiptail, 18, 160
white mold, 158
white-rust, [46], 47, 158
wirestem, 62, 156

Cactus, 161

anthracnose, 36, 161
bacterial soft rot, 68, 161
black mildew, 48, 161
bud drop, 161
cladode rot, 63, 161
collar rot, 62, 161

corky scab, 28, 161

cutting rot, 62, 161
glassiness, 161
gray-mold rot, 37, 161
kinds

barrel (*Echinocactus*), 161
Christmas (*Epiphyllum*), 161

crab (*Epiphyllum*), 161
fishhook (*Mammillaria*), 161

pincushion (*Mammillaria*), 161
sea-urchin (*Echinocactus*), 161

star (*Echinocactus*), 161
Thanksgiving (*Epiphyllum*), 161

root-knot, cyst nematode, 75, 161
root nematode, 161
scorch, "sunscald," 161

seed and cutting treatment, 161, 433
seedling blight, 62, 161
stem and root rot, 62, 73, 161

Caddy, 267, 269

Cadminate, 267, 270

Cadtrete, 267, 270

Caesalpinia, 248

anthracnose, 36, 249, 284
canker, dieback, 63, 248
crown gall, 68, 117, 249
root rot, 73, 117, 248
rust, 45, 249

Calabash; *see* Gourds

Caladium, 162

bacterial soft rot, 68, 162
downy mildew, 40, 163
gray-mold blight, 37, 163
leaf spot, 33, 163

root-knot, 75, 162

root nematode, 162

root rot, 73, 162

southern blight, stem rot, 62, 162

tuber rot, 162

tuber soak, 162, 429, 433

Calathea, 347

leaf spot, 33, 347

Calceolaria, 368

aster yellows, 58, 370

boron deficiency, 17

flower blight, 37, 70, 185, 370

gray-mold blight, 37, 368

leaf nematode, 61, 370

mosaic, 57, 369

root rot, 73, 369

seed treatment, 369

soil drench, 369

spotted wilt, ringspot, 57, 370

stem or collar rot, 62, 369

verticillium wilt, 53, 369

Calcinium arsenate, 409

Calcinium deficiency, 17

Calcinium hypochlorite; *see* Bleach, household

Calendula, 181

aster yellows, 59, 183

black mold, 48, 186

crown gall, 68, 186

gray-mold blight, 37, 185

leaf blight, 36, 181

leaf spot, 33, 181

- Calendula (continued)**
- mosaic, 57, 184
 - powdery mildew, 41, 183
 - root-knot, 75, 134, 185
 - root rot, 73, 183
 - rust, 45, 184
 - southern blight, 62, 183
 - spotted wilt, ringspot, 57, 184
 - stem rot, 62, 63, 183
 - white smut, [50], 186
- Calico**, 55
- California-bluebell; see Phacelia**
- California buckeye; see Buck-eye**
- California fremontia; see Fremontia**
- California fuchsia; see Fuchsia, Zauschneria**
- California-hyacinth**, 151
- California-laurel**, 127
- bacterial leaf spot, 33, 127
 - black mildew, 48, 128
 - canker, dieback, 63, 127
 - leaf blight, 36, 127
 - root nematode, 128
 - wood rot, 64, 127, 142, 211
- California-poppy**, 338
- aster yellows, 59, 339
 - bacterial blight, 33, 338
 - gray-mold blight, 37, 339
 - leaf mold or spot, 33, 338
 - leaf smut, 50, 339
 - powdery mildew, 41, 339
 - root-knot, 75, 339
 - seed treatment, 338, 429, 433
 - spotted wilt, 57, 339
 - stem rot, 62, 338
 - verticillium wilt, 53, 338
- California-rose**, 290
- leaf spot, 33, 290
 - root rot, 73, 291
 - rust, 45, 290
 - white-rust, 47, 158, 290
- California Spray-Chemical Corporation**, 86, 87, 88, 89, 104, 419
- California sweetshrub**, 164
- Calla**, 162
- bacterial soft rot, 68, 162
 - corn (rhizome) treatment, 162, 428, 429, 433
 - flower blight, 70, 163
 - gray-mold blight, 36, 37, 70, 163
 - leaf spot, 33, 163
 - mosaic, 55, 163
 - rhizome or corm rot, 62, 68, 162
 - root-knot, 75, 162
 - root rot, 73, 162, [163]
 - southern blight, 62, 162
 - spotted wilt, 57, 162
- Calla lily; see Calla**
- Calliandra**, 164
- root rot, 73, 164
- Callicarpa**, 263
- black mildew, 48, 263
 - dieback, canker, 63, 118, 264
 - leaf spot, 33, 263
 - root nematode, 264
- Callirhoe**, 246
- Callistephus**, 181
- Calluna**, 243
- Callus growth**, [24]
- Calochortus**, 286
- rust, 45, 286
- Calo-clor**, 85, 268, 269
- Calocure**, 85, 267, 268, 269, 270
- Calonyction**, 290
- Calycanthus**, 164
- canker, 63, 164
 - crown gall, 68, 164
 - powdery mildew, 41, 164
- Camass**, 189
- botrytis blight, 37, 190, 399
 - leaf spot, 33, 190
 - root rot, 73
 - smut, 47, 189
- Camassia**, 189
- Camellia**, 164
- black mold or mildew, 48, 166
 - bud drop, 165
 - bud and flower blight (*Botritis*), 37, 70, 166
 - bud rot, 166
 - chlorosis, 16, 167
 - crown gall, 68, 167
 - dieback, canker, 63, 164
 - flower blight, 70, 164, [165]
 - graft blight, 164
 - leaf blight, blotch, 36, 165
 - leaf curl, 47, 166
 - leaf and flower variegation, 166
 - leaf spot, 33, [165]
 - leaf and stem gall, 47, [166]
 - oedema, 28, 167
 - root-knot, 75, 167
 - root nematode, 167
 - root rot, 73, 167
 - sooty mold, 48, 166
 - spot anthracnose or scab, 36, 165
 - sunscald, 28, 165
 - yellow mottle, 166
- Camomile**, 181
- aster yellows, 59, 183
 - damping-off, seed rot, 62, 183
 - root-knot, 75, 134, 185
 - root rot, 73, 183
 - seed treatment, 183
- Campanula**, 140; *see also Bell-flower, Canterbury-bells*
- aster yellows, 59, 141
 - crown rot, 62, 140
 - curly-top, 60
 - leaf spot, 33, 140
 - leaf and stem nematode, 61, 141
 - powdery mildew, 41, 141
 - root-knot, 75, 141
 - root rot, 73, 140
 - rust, 43, 141
 - southern blight, 62, 140
 - spotted wilt, 57, 141
 - stem rot, 62, 140
 - verticillium wilt, 53, 141
- Camphor-tree**, 127
- anthracnose, 36, 127
 - black mildew, 48, 128
 - canker, dieback, 63, 127
 - chlorosis, 16, 128
 - leaf spot, 33, 127
 - mistletoe, 79, 128
 - powdery mildew, 41, 128
 - root nematode, 128
- root rot**, 73, 127
- spot anthracnose or scab**, 50, 127
- verticillium wilt**, 53, 128
- Campion (*Silene*)**, 169; *see also Evening campion, Red campion*
- anther or flower smut, 47, 171
 - rust, 45, 169
- Campsis**, 399
- Camptosorus**, 223
- Canarybirdflower**; *see Nass-turtium, garden*
- Canary ivy**; *see Ivy*
- Canavalia**, 131
- Candleberry**; *see Waxmyrtle*
- Candles of the Lord**; *see Yucca*
- Candytuft**; *see also Cabbage*
- clubroot, 73, 156
 - damping-off, 62, 156
 - downy mildew, 40, 157
 - gray-mold blight, 37, 158
 - mosaic, 57, 159
 - powdery mildew, 41, 160
 - ringspot, 57, 159
 - root-knot, 75, 134, 158
 - root rot, 73, 160
 - white-rust, 47, 158
- Cane**
- blight, 63
 - canker, [63]
 - gall, 68, [69]
- Canker**, 10, [63], [65]
- bacterial, 66
 - bleeding, 135, 255
 - branch, 63
 - cane, [63]
 - stem, 63
 - trunk, 63
 - twig, 63
- Canna**, 167
- aster yellows, 59, 168, 183
 - bacterial bud rot and stalk rot, 33, [167]
 - bacterial wilt, 55, 168, 395
 - leaf spot, 33, 168
 - mosaic, 57, 168
 - rhizome or tuber rot, 62, 68, 168
 - root nematode, 168
 - rootstock soak, 168, 428, 433
 - rust, 45, 168
 - southern blight, crown rot, 62, 168
- Cantaloup**, 196; *see also Cucurbit, Muskmelon*
- anthracnose, 36, 196
 - bacterial leaf spot, 33, 197
 - bacterial wilt, 55, 197
 - curly-top, 60, 199
 - downy mildew, 40, 199
 - fruit rot, 68, 70, 198, 200
 - fusarium wilt, 53, 198
 - leaf blight, 36, 197
 - mosaic, 57, 199
 - powdery mildew, 41, 199
 - ringspot, 58, 200
 - scab, 50, 197
 - seed treatment, 196, 427, 431
 - verticillium wilt, 53, 200
- Canterbury-bells**, 140
- aster yellows, 59, 141
 - powdery mildew, 41, 141

- root-knot, 75, 141
 root rot, 73, 140
 rust, 45, 141
 southern blight, 62, 140
 spotted wilt, 57, 141
 stem rot, 62, 140
Cape-cowslip, 399; *see also Tulip*
 mosaic, 57, 401
Cape gooseberry; *see Ground-cherry*
Cape honeysuckle, 399
 anthracnose, 36, 399
 root rot, 73, 117, 399
Cape-jasmine; *see Gardenia*
Cape-marigold, 181
 aster yellows, 59, 183
 fusarium wilt, 53, 184
 gray-mold blight, 37, 185
 mosaic, 57, 184
 root-knot, 75, 134, 185
 root rot, 73, 183
 rust, 45, 184
 verticillium wilt, 53, 141, 184
Capsicum, 389
Captan
 bulb dip, 205
 dip for fruits and vegetables, 86, 315, 377
 gallon lots, 422
 in multipurpose mixes, 86, 91, 419, 423-25
 seed treatment, 63, 67, 82, 86, 419, 430
 soil application, 62, 63, 82, 85, 86, 92, 156, 183, 266, 274, 354, 442
 spray or dust, 33, 39, 50, 70, 86, 419
 trade names and distributors, 86, 419
 uses, 86, 419
Captan 50-W, 86, 419
Dieldrin 60-15 Seed Protectant, 86, 419, 430
80 Spray-Dip, 86, 419
Garden Spray, 86, 419
75 Seed Protectant, 86, 419, 430
Caragana, 248
Caranda; *see Carissa*
Caraway, 175
 aster yellows, 59, 172, 176
 mosaic, 57, 176
 root-knot, 75, 176
 seed rot, damping-off, 62, 176
 seed treatment, 176, 431
 stem rot, 62, 176
Carbamate, 86, 419
Cardinal climber; *see Cypress-vine*
Cardinalflower; *see Lobelia*
Cardoon; *see also Globe artichoke*
 leaf spot, 33, 274
 powdery mildew, 41, 274
 yellows, 59, 273
Carex, rust, 43
Carissa, 298
 canker, dieback, 63, 298
 leaf spot, 33, 298
 root-knot, 75, 298, 323
 root rot, 73, 117, 298
Carnation, 169
 anther smut, 47, 171
 anthracnose, 36, 170
 aster yellows, 59, 170, 183
 bacterial leaf spot, 33, 171
 bacterial wilt, 55, 169
 boron deficiency, 171
 branch rot, 63, 169
 crown gall, 68, 171
 curly-top, [60], 170
 cutting dip, 169, 170
 cutting rot, 62, 169
 downy mildew, 40, 171
 fasciation or leafy gall, 67, 171, 314
 flower blight, 37, 70, 170
 fusarium bud rot, 170
 fusarium wilt or yellows, 53, 169
 gray-mold blight, 37, 170
 greasy blotch, 170
 leaf spot, 33, 169, 170
 leaf and stem nematode, 61, 171
 mosaic, [56], 57, 170
 mottle, 57, 170
 plant dip, 171
 powdery mildew, 41, 110, 171
 ringspot, 57, 170
 root-knot, 75, 171
 root nematode, 171
 root rot, 73, 169
 rust, 43, 45, 169, [170]
 southern blight, 62, 169
 stem, collar rot, 62, 169
 streak, 170
 verticillium wilt, 53, 169
 web blight, 134, 171
Carnegiea, 161
Carolina allspice, 164
Carolina jessamine, 153
 black mildew, 48, 153
 black spot, 33, 153
 leaf spot, 33, 153
 root rot, 73, 117, 153
 silky thread blight, 153, 409
 sooty mold, 48, 153
Carolina moonseed, 290
 burrowing nematode, 290
 leaf spot, 33, 290
 root rot, 73, 290
Carosel, 135
Carpetgrass, 265; *see also Blue-grass*
 brown patch, 267
 dollar spot, 267
 leaf blight, 36, 265
 leaf spot, 33, 265
 Pythium disease, 269
 root nematode, 269
 rust, 45, 266
Carpinus, 142
Carrot, 171
 aster yellows, [59], 172
 bacterial blight, 33, 171
 bacterial soft rot, 68, 70, 172
 bacterial wilt, 55, 173, 395
 boron deficiency, 17, 173
 cottony rot, 62, 172
 crown gall, 68, 173
 curly-top, 60, 136, 173
 damping-off, 62, 172
 downy mildew, 40, 173
 dry rot (*Fusarium*), 53, 63, 70, 172
 fertilizing, 19
 gray-mold rot, 37, 172
 leaf blight, 36, 171
 leaf spot, 33, 171
 mosaic, 57, 173
 motley dwarf, 59, 173
 ringspot, 57, 173
 root-knot, cyst nematode, [77], 172
 root nematode, 172
 root rot, 73, 172
 rust, 45, 173
 scab, 50, 138, 172, 339
 seed rot, 172
 seed treatment, 172, 428, 431
 southern blight, 62, 172
 stem nematode, 61, 172
 storage rot, 70, 172
 watery soft rot, 70, 132, 172
 web blight, 134, 173
Carthamus, 181
Cart sprayer, 95
Carum, 175
Carya, 406
Caryopteris; *see Verbena*
Caryota, 307
Cassaba, 196 *see also Cucurbit*, Muskmelon
 anthracnose, 36, 196
 bacterial leaf spot, 33, 197
 bacterial wilt, 55, 197
 curly-top, 60, 199
 downy mildew, 40, 199
 fruit rot, 68, 70, 172, 200
 fusarium wilt, 53, 198
 leaf blight, 36, 197
 mosaic, 57, 199
 ringspot, 57, 200
 scab, 50, 197
 seed treatment, 196
 verticillium wilt, 53, 200
Cassabana; *see Sicana*
Cassandra; *see Chamaedaphne*
Cassia, 248
 dieback, 63, 248
 leaf spot, 33, 249, 286
 powdery mildew, 41, 248
 root-knot, 75, 249, 323
 root rot, 73, 117, 248
Cassiope, 145
 leaf gall, 47, 146
Castanea, 179
Castanopsis, 179
Castilleja, 368
Cast-iron plant, 126
Castonopsis; *see Golden chin-quapin*
Castorbean, 173
 bacterial leaf spot, 33, 174
 bacterial wilt, 55, 174
 capsule mold, 174
 crown gall, 68, 174
 gray mold blight, flower blight, 36, 37, 70, 173
 leaf spot, 33, 174
 red gall, 47, 174
 root-knot, 75, 174
 root nematode, 174
 root rot, 73, 117, 132, 174
 seed rot, 174
 seed treatment, 174

- Castorbean (continued)**
 seedling blight, 62, 174
 southern blight, 62, 174
 stem, crown rot, 62, 174
 verticillium wilt, 53, 174
- Catalpa, 174**
 anthracnose, 36, 174
 chlorosis, 16, 175
 crown gall, 68, 175
 damping-off, southern blight, 62, 175, 333
 dieback, canker, 63, 118, 285
 leaf scorch, 28, 175, 284
 leaf spot, 33, 174
 powdery mildew, 41, 174
 root-knot, 75, 175, 323
 root rot, 73, 117, 175
 sooty mold, 48, 175, 220
 spot anthracnose, 36, 174
 verticillium wilt, 53, 175, 284
 wood rot, 64, 142, 174
- Catasetum, 302**
- Catchfly; see Silene**
- Catclaw; see Acacia**
- Catha, 143**
- Catnip, 362**
 bacterial leaf spot, 33, 363
 fusarium wilt, 53, 363
 leaf spot, 33, 362
 mosaic, 57, 363
 root rot, 73, 231, 363
 southern blight, 62, 208, 363
- Cattleya, 302**
- Cauliflower, 154; see also Cabbage**
 aster yellows, 59, 160
 bacterial leaf spot, 33, 158
 bacterial soft rot, 68, 70, 157
 black ringspot, 57, 159
 black rot, 33, 156
 blackleg, 63, 155
 boron deficiency, 17, 158
 chlorosis, magnesium deficiency, 16, 18
 clubroot, 75, 156
 curly-top, 60, 159
 damping-off, 62, 155, 156, 157
 downy mildew, 40, 157
 drop, cottony rot, 62, 70, 158
 fusarium yellows, 53, 155
 gray-mold blight, 37, 158
 head browning (*Alternaria*), 70, 157
 leaf blight, 36, 157
 leaf mold, 33, 157
 leaf spot, 33, 157
 mosaic, 57, 159
 oedema, 28, 160
 powdery mildew, 41, 160
 root-knot, 75, 134, 158
 root nematode, 160
 root rot, 73, 160
 seed treatment, 156, 428, 431
 southern blight, 62, 158
 spotted wilt, 57, 159
 storage rot, 70, 157, 158
 tipburn, 158
 verticillium wilt, 53, 160
 whiptail, molybdenum deficiency, 18, 160
 white-rust, 47, 158
- Caulophyllum, 129**
- Ceanothus, 294**
- Cedar (*Cedrus*), 330; see also Chamaecyparis for Incense-cedar, Port Orford or Lawson, White-cedar, and Yellow-cedar, *see Juniper* for Red-cedar**
 canker, dieback, 63, 331
 root rot, 73, 117, 333
 tip blight, 330
 wood rot, 64, 142, 330
- Cedar of Lebanon; see Cedar**
- Cedrela, 179; see also Chinaberry**
 wood rot, 64, 180
- Cedrus, 330**
- Celandine, 338**
 leaf spot, 33, 338
 root rot, 73, 338
- Celastrus, 143**
- Celeriac, 175; see also Celery**
 aster yellows, 59, 172, 176
 bacterial soft rot, 68, 176
 curly-top, 60, 136, 177
 damping-off, 62, 176
 leaf blight, 36, 175
 mosaic, 57, 176
 ringspot, 57, 177
 seed treatment, 176, 428, 431
 spotted wilt, 57, 177, 393
 stem nematode, 60, 177
 verticillium wilt, 53, 177
- Celery, 175**
 aster yellows, 59, 172, 176
 bacterial petiole spot, 33, 177
 bacterial soft rot, 68, 176
 bacterial spot, blight, 33, 175
 blackheart or heart rot, 176
 boron deficiency, stem-cracking, 17, 18, 177
 calico, 57, 176
 crown rot, 62, 177
 curly-top, 60, 136, 177
 damping-off, 62, 176
 downy mildew, 40, 173, 177
 fusarium wilt or yellows, 53, 176
 gray-mold rot, 37, 176
 leaf blight, [36], 175
 leaf spot, 33, 175
 mosaic, 57, 176
 motley dwarf, 59, 176
 ringspot, 57, 177
 root-knot, 75, 176
 root nematode, 177
 root rot, 73, 177
 seed rot, 176
 seed treatment, 176, 428, 431
 spotted wilt, 57, 177, 393
 stem nematode, 61, 177
 stem rot, 62, 172, 176
 storage rot, 70, 172, 176
 streak, 176
 temperature, effect on, 28
 verticillium wilt, 53, 177
 yellow spot, 176
- Celosia, 189**
- Celtis, 241**
- Celtuce, 272; see also Lettuce**
 downy mildew, 40, 273
 drop, watery soft rot, 272
 leaf spot, 33, 274
- Centaurea, 181**
 aster yellows, 59, 183
- curly dwarf, 59, 184**
 downy mildew, 40, 185
 fusarium wilt, 53, 184
 gray-mold blight, 37, 185
 powdery mildew, 41, 183
 root-knot, 75, 134, 185
 root rot, 73, 183
 rust, 45, 184
 southern blight, 62, 183
 stem or crown rot, 62, 183
 verticillium wilt, 53, 141, 184
 white-rust, 47, 186
- Centigrade, conversion to Fahrenheit, 418**
- Centipede grass, 265; see also Bluegrass**
 anthracnose, 36, 265
 brown patch, 267
 dollar spot, 267
 leaf spot, blotch, 33, 265
 root nematode, 269
- Centranthus, 403**
- Centrosema, 311**
- Century plant, 178**
 anthracnose, black rot, 36, 178
 gray-mold blight, 37, 139, 178
 leaf scorch, blight, 36, 178
 leaf spot, 33, 178
- Cephalanthus, 154**
- Cephalotaxus; see Japanese plum-yew**
- Cercis, 248**
- Ceresan 2%, 205**
- Ceresan 200, 233, 449**
 seed treatment, 324
- Cereus, 161; see also Cactus**
 anthracnose, 36, 161
 bacterial soft rot, 68, 161
 bud drop, 161
 collar rot, 62, 161
 corky scab, glassiness, 28, 161
 fusarium wilt, 53, 161
 gray-mold blight, 37, 161
 leaf scorch, 36, 161
 leaf spot, 33
 root-knot, cyst nematode, 75, 161
 root and stem rot, wilt, 62, 73, 161
 stem and branch rot, 62, 161
- Ceriman; see Monstera**
- Chaenomeles, 114**
- Chaerophyllum, 175**
- Chamaecyparis, 259**
 canker, twig and branch, 64, 260
 crown gall, 68, 117, 260
 dieback, 64, 260
 leaf blight, 36, 260
 nursery or juniper blight, 36, 64, 260
 root rot, 73, 117, 260
 rust
 gall, 45, 259
 leaf, 45, 259
 witches'-broom, 45, 259
 twig blight, 64, 260
 winter injury, sunscorch, 28, 260
 wood rot, 64, 142, 260
- Chamaedaphne, 145**
 leaf gall, 47, 146

- leaf spot, 33, 147
rust, 45, 146
- Champion Sprayer Company, 104
- Chaste-tree, 263
leaf spot, 33, 263
root rot, 73, 264
- Chayote, 196; *see also* Cucurbit
anthracnose, 36, 196
fruit rot, 70, 200
leaf spot, 33, 197
mosaic, 57, 199
root-knot, 75, 200
root nematode, 200
seed treatment, 196, 431
southern blight, 62, 200
verticillium wilt, 53, 200
- Checkerberry, 243
fruit spot, 70, 243
leaf spot, 33, 243
powdery mildew, 41, 243
red leaf gall, 243
sooty mold or blotch, 48, 243
- Checkermallow; *see* Sidalcea
- Cheiranthus, 155
- Chelates, 17
iron, 17
manganese, 17
zinc, 17
- Chelidonium, 338
- Chelone, 368
- Chem-vape, 443
- Chemical injury, 29–30, 437
- Chemical soil treatments, 439–44
- Chemley Products Company, 89, 104
- Chemotherapeuticant, 84
- Cherry, 315; *see also* Flowering cherry
bacterial canker, 66, 318
bacterial leaf spot, 33, 318
black knot, [66], 317
blossom blight, 66, 70, 315
brown rot, 36, 70, 315
chlorosis, 16–18, 285, 323, 407
coryneum blight, 36, 63, 322
crown gall, 68, 322
dieback, 63, 315, 322
felt fungus, 241, 324
fire blight, 66, 70, 114, 324
fruit spot or rot, 37, 70, 315, 318, 323
leaf blister, 47, 316
leaf spot or yellow leaf, 33, [317], 323
mistletoe, 79, 324
mottle complex, 57, 321
powdery mildew, 41, 322
prune dwarf, 59, 320
pruning, 21
rasp leaf, leaf enation, 321
ringspot, 57, 320
root-knot, 75, 323
root nematode, 323
root rot, 73, 117, 323
rosette, 59, 319
rust, 45, 322
scarf, 50, 70, 318
shot-hole, 37, [38], 317, 318, 322, 323
sour cherry yellows, 59, 319
spray schedule, 424–25
trunk canker, 63, 315
- twig blight, 63, 315, 322
verticillium wilt, 53, 322
- witches'-broom, 47, [48], 316
- wood rot, 64, 142, 316
X-disease, 318
- Cherry-laurel, 315; *see also*
Cherry
bacterial spot, 33, 318
blossom blight, 70, 315
brown rot, 36, 70, 315
fire blight, 66, 70, 114, 324
leaf spot, 33, 317, 323
mistletoe, 79, 324
powdery mildew, 41, 322
root rot, 73, 117, 323
shot-hole, 37, 317, 318, 322, 323
thread blight, 324, 409
twig blight, 63, 315, 322
verticillium wilt, 53, 322
witches'-broom, 47, 316
- Chervil, 175; *see also* Celery
crown rot, 62, 177
curly-top, 60, 136, 177
downy mildew, 40, 173, 177
mosaic, 57, 176
root-knot, 75, 176
root rot, 73, 177
seed rot, damping-off, 62, 176
seed treatment, 176
streak, 176
verticillium wilt, 53, 177
- Chestnut, 179
anthracnose, 36, 179, 284
canker, blight, 63, 179
dieback, 63, 179
leaf spot, 33, 179, 284
mistletoe, 78
nut rot, 70, 179
oak wilt, 179, 295
powdery mildew, 41, 179
root rot, 73, 117, 179
rust, 41
twig blight, 63, 179
wood rot, 64, 179
- Chickweed
rust, 44
virus source, 58
- Chicory, 272
anthracnose, 36, 274
aster yellows, 59, 273
bacterial rot, 33, 274
bacterial soft rot, 68, 272
bottom rot, 62, 63, 272
damping-off, 62, 274
downy mildew, 40, 273
drop, 272
gray-mold blight, rot, 37, 273
leaf spot, 33, 274
mosaic, 57, 273
powdery mildew, 41, 274
ringspot, 57, 275
root-knot, 75, 134, 275
root nematode, 275
root rot, 73, 274
rust, 45, 274
seed rot, 274
seed treatment, 274, 431
slime mold, 267, 275
southern blight, 62, 272
spotted wilt, 57, 275
tipburn, 273
verticillium wilt, 53, 275
- Chilopus, 174
- China-aster, 181
anthracnose, 36, 181
aster yellows, [59], 183
blossom blight, 70, 184
botrytis blight or gray-mold, 37, [39], 70, 184
curly dwarf, 59, 184
curly-top, 60, 184
downy mildew, 40, 185
fusarium wilt, [52], 53, 184
leaf blight, 36, 181
leaf spot, 33, 181
mosaic, 57, 184
powdery mildew, 41, 183
ringspot, 57, 184
root-knot, 75, 134, 185
root nematode, 186
root rot, 73, 183
rust, 43, 45, 184
seed treatment, 182, 184, 428, 433
southern blight, 62, 183
spotted wilt, 57, 184
stem canker, 63, 185
stem or foot rot, 62, 183, 184, 185
verticillium wilt, 53, 141, 184
- China tree; *see* Chinaberry
- Chinaberry, 179
black mildew, 48, 180
canker, limb blight, 63, 179
downy mildew, 40, 179
leaf spot, 33, 179
mistletoe, 79, 180
powdery mildew, 41, 180
root-knot, 75, 180, 323
root rot, 73, 117, 180
sooty mold, 48, 180
thread blight, 180, 409
twig blight, 63, 179
verticillium wilt, 53, 284
wood rot, 64, 180
- Chinese beauty-bush; *see* Beauty-bush
- Chinese bellflower, 140; *see also* Balloonflower
- Chinese cabbage, 154; *see also* Cabbage
anthracnose, 36, 157
aster yellows, 59, 160
bacterial leaf spot, 33, 158
bacterial soft rot, 68, 157
black rot, 33, 156
blackleg, 63, 155
clubroot, 73, 156
curl-top, 60, 159
damping-off, 62, 155, 156, 157
downy mildew, 40, 157
leaf spot, 33, 157
mosaic, 57, 159
powdery mildew, 41, 160
root-knot, 75, 134, 158
southern blight, 62, 158
white-rust, 47, 158
- Chinese evergreen, 162
bacterial leaf spot, 33, 163
bacterial soft rot, 67, 162
leaf rot, 36, 163
plant soak, 162, 433
root-knot, 75, 162
root nematode, 162
root rot, 73, 162
stem rot, 62, 162

- Chinese forget-me-not; *see* Houndstongue
 Chinese hibiscus; *see* Hibiscus (arborescent forms)
 Chinese houses; *see* Collinsia
 Chinese lanternplant, 389
 angular leaf spot, 33, 391
 bacterial wilt, 55, 395
 curly-top, 60, 394
 leaf spot, 33, 390
 leaf and stem nematode, 60, 328, 397
 mosaic, 57, 392
 ringspot, 57, 394
 root-knot, 75, 395
 root rot, 73, 396
 rust, 45, 397
 southern blight, 62, 396
 spotted wilt, 57, 393
 verticillium wilt, 53, 395
 white smut, 50, 397
 wildfire, 33, 391
 Chinese parasoltree; *see* Phoenix-tree
 Chinese scholar-tree; *see* Sophora
 Chinese stranvaesia; *see* Stranvaesia
 Chinese tallowtree, 173
 leaf spot, 33, 174
 root rot, 73, 174
 Chinese trumpetcreeper, 141
 Chinese waxgourd, 196; *see also* Cucurbit
 anthracnose, 36, 196
 downy mildew, 40, 199
 root-knot, 75, 200
 seed treatment, 196
 Chinese wolfberry; *see* Matrimony-vine
 Chinquapin, 179; *see also* Chestnut, Golden chinquapin, Oak
 blight, canker, 63, 179
 brown felt canker, 241
 leaf blister, 47, 179, 295
 leaf spot, 33, 179, 284
 oak wilt, 179, 295
 powdery mildew, 41, 179
 root rot, 73, 117, 179
 wood rot, 64, 179
 Chionanthus, 124
 Chionodoxa, 399
 Chipman Chemical Company, Incorporated, 89, 104
 Chives, 299; *see also* Onion
 bulb nematode, 78, 300
 bulb rot, 75, 299
 downy mildew, 40, 300
 gray-mold blight, 37, 299
 rust, 45, 302
 seed treatment, 432
 smut, 47, 299
 verticillium wilt, 53, 302
 Chloranil
 gallon lots, 422
 seed, corm and bulb treatment, 63, 82, 86, 419, 430
 soil drench, 86, 419
 spray or dust, 39, 41, 86, 419
 trade names and distributors, 86, 419
 uses of, 86, 419
 Chlordane, 53, 68, 83, 266
 Chlorine tablet, 303
 Chloropicrin
 disinfesting soil, 70, 77, 89, 442
 mixture with methyl bromide, 443
 precautions, 442
 storage fumigation, 382
 trade names, 442
 Chlorosis, 16, 285
 controlling, 16, 285
 iron, 17, 285
 Chokeberry, 114; *see also* Apple blossom blight, 70, 116
 canker, dieback, 63, 118
 fire blight, 66, 116
 fruit rot, 70, 118
 rust, 43, 45, 116
 Chokecherry; *see* Cherry, Peach
 Cholla; *see* Cactus, Opuntia
 Christmas cactus; *see* Cactus, Epiphyllum
 Christmas cherry; *see* Jerusalem-cherry, Eggplant
 Christmas-rose, 208
 black spot, blight, 33, 36, 209, [210]
 flower spot, 70, 210
 gray-mold blight, 37, 208, 209, 210
 soil drench, 208
 stem or crown rot, 62, 208
 Christmasberry; *see* Photinia
 Chrysanthemum, 181
 aster yellows, 59, 183
 bacterial blight, 33, 186
 bacterial soft rot, 68, 183
 bacterial wilt, 55, 184
 blossom blight, 70, 184
 crown gall, 68, 186
 crown rot, [62], 183
 cutting dip, 181
 cutting rot, 62, 183
 damping-off, seed rot, 62, 183
 fasciation, 67, 186
 fusarium wilt, 53, 184
 gray-mold blight, 37, 185
 head blight, 70, [71], 185
 leaf blight, 36, 181, [182]
 leaf or foliar nematode, [61], 185
 leaf spot, 33, 181, [182]
 light, effect on flowering, 27
 mosaic, 57, 184
 plant soak, 186, 429, 433
 powdery mildew, 41, [182], 183
 ray blight, 70, 185
 ringspot, 57, 184
 root-knot, 75, 134, 185
 root nematode, 186
 root rot, [62], 73, 183
 rosette, 59, 184
 rust, 43, 45, 184, [185]
 seed treatment, 183
 soil drench, 183
 southern blight, 62, 183
 spotted wilt, ringspot, 57, 184
 stem rot, canker, 62, 63, 156, 183, 185
 stunt, 59, 183, 184
 verticillium wilt, 53, 141, 184
 yellow dwarf, 59, 184
 Chrysopsis, 181
 Chuperosa, 188
 rust, 45, 188
 Cichorium, 272
 Cigarflower, 186
 gray-mold blight, 37, 187
 leaf spot, 33, 187
 powdery mildew, 41, 187
 root-knot, 75, 187
 root rot, 73, 187
 Cimicifuga, 112
 black mildew, 48
 leaf spot, 33, 112
 root-knot, 75, 113
 rust, 45, 112
 smut, 47, 113
 Cinchona, 154
 leaf spot, 33, 154
 root-knot, 75, 154
 root rot, 73, 117, 154
 Cineraria, Florists', 181; *see also* Senecio
 aster yellows, 59, 183
 damping-off, seed rot, 62, 183
 downy mildew, 40, 185
 fusarium wilt, 53, 184
 gray-mold blight, 37, 185
 mosaic, 57, 184
 powdery mildew, 41, 183
 root-knot, 75, 134, 185
 root rot, 73, 183
 seed treatment, 183
 spotted wilt, 57, 184
 stem rot, 62, 183
 verticillium wilt, 53, 141, 184
 Cinnamomum, 127
 Cinnamon-tree, 127; *see also* Camphor-tree
 anthracnose, 36, 127
 leaf spot, 33, 127
 Cinnamomvine; *see* Yam
 Cinquefoil; *see* Potentilla
 Cirsium; *see* Thistle, Plumed thistle
 Cissus, 237; *see also* Grape
 leaf spot, 33, 237, 240
 root rot, 73, 117, 239
 rust, 45, 240
 smut, 47
 Citron, 196; *see also* Cucurbit, Watermelon
 anthracnose, 36, 196
 curly-top, 60, 199
 downy mildew, 40, 199
 fruit rot, 68, 70, 172, 200
 fusarium wilt, 53, 198
 mosaic, 57, 199
 powdery mildew, 41, 199
 scab, 50, 197
 seed treatment, 196
 verticillium wilt, 53, 200
 Citrus, 187
 anthracnose, withertip, 35, 187
 bacterial blast, 33
 chlorosis, 16, 187
 collar rot, 62, 63, 187, 211
 crown gall, 68, 187
 damping-off, 62
 fruit rot, 70
 Handbook of Citrus Diseases in Florida, 188
 leaf spot, 33, 187
 leaf yellowing, 187
 mistletoe, 78

- other diseases, 187
 plant soak, 187, 429, 436
 root-knot, 75, 187
 root nematode, 187
 root rot, 73, 187
 scab or spot anthracnose, 50, 187
 sooty blotch or mold, 48, 187
 tree decline, 187
 twig blight, 63, 187
 withertip, 187
 wood rot, 64
- Cladrasitis*, 248
Clarkia, 228
 anthracnose, 36, 181, 228
 aster yellows, 59, 183, 228
 damping-off, 62, 228
 downy mildew, 40, 185, 228
 fusarium wilt, 53, 184, 228
 gray-mold blight, 37, 228
 leaf spot, 33, 181, 228
 rust, 45, 228
 stem canker, 63, 228
 stem rot, 62, 183, 228
 verticillium wilt, 53, 228
- Clearly*, W. A. Corporation, 89; 106
Cleistothecia, 42
Clematis, 188
 black mildew, 48
 crown gall, 68, 188
 leaf blight, 36, 188
 leaf spot, 33, 188
 mosaic, 57, 188
 powdery mildew, 41, 188
 root-knot, 75, 188
 root nematode, 188
 rust, 43, 45, 188
 smut, 47, 188
 stem rot, wilt, 62, 63, 188
- Cleome*, 374
Clerodendron, 263
 leaf spot, 33, 263
 root-knot, 75, 263
- Clethra*, 381
 leaf spot, 33, 381
 root rot, 73, 381
- Cliffgreen*, 143
 leaf spot, 33, 144
- Cliftonia*, 153
- Climbing mignonette*; *see* *Bous-singaultia*
- Clinopodium*, 362
Clitoria, 311
Clockvine, 188
 aster yellows, 59, 189
 crown gall, 68, 189
 root-knot, 75, 189
 root nematode, 189
- Cloud berry*; *see* *Blackberry*, *Raspberry*
- Clove currant*; *see* *Flowering currant*
- Clubroot*, 73, [75]
CM-19, 449
Cnicus, 181
 southern blight, 62, 183
- Cocculus*, 290
Cochlearia, 155
Cockscomb, 189
 black ringspot, 57, 159, 189
 curly-top, 60, 136, 189
 damping-off, seed rot, 62, 189
- leaf blight, spot, 33, 36, 181, 189
 leaf roll, 189, 341
 root-knot, 75, 189
 root nematode, 189
 root rot, 73, 189
 stem rot, 62, 189
- Coconut*, 307
Cocos, 307
C-O-C-S, 88
Codiaeum, 196
Coffeeberry, 152; *see also* *Buck-thorn*
 leaf spot, 33, 152
 rust, 45, 152
 sooty mold, 48, 152
- Coffeetree*; *see* *Kentucky coffee-tree*
- Cohosh*; *see* *Baneberry*, *Blue cohosh*, *Cimicifuga*
- Colchicum*, 189
 corm rot, 73, 75, 190, 400
 leaf spot, 33, 37, 190
 smut, 47, 189
 tip blight (*Botrytis*), 37, 190, 399
- Coleus*, 362
 blossom blight, 70, 363
 cutting rot, 62, 363
 damping-off, 62, 208, 363
 gray-mold rot, 37, 363
 leaf nematode, 61, 363
 leaf spot, blight, 33, 37, 362, 363
 mosaic, 57, 363
 root-knot, 75, 362
 verticillium wilt, 53, 363
- Collar rot*, 62, 67
- Collards*; *see also* *Cabbage*
 anthracnose, 36, 157
 bacterial leaf spot, 33, 158
 bacterial soft rot, 68, 156
 clubroot, 75, 156
 curly-top, 60, 159
 downy mildew, 40, 157
 fusarium yellows, 53, 155
 powdery mildew, 41, 160
 seed treatment, 156, 428, 431
 verticillium wilt, 53, 160
- Colleges, Land-grant*
 help by, 3
 listing of, 4-5
- Collinsia*, 368
 leaf spot, 33, 369
 root rot, 73, 369
 rust, 45, 368
 soil drench, 369
 white smut, 50, 371
- Collomia*, 327
 powdery mildew, 41, 327
 rust, 45, 328
 stem and bulb nematode, 78, 328
- Colocasia*, 162
Coltsfoot, 181
 leaf spot, 33, 181
- Columbine*, 208
 curly-top, 60, 210
 damping-off, 62, 209
 gray-mold blight, 37, 208
 leaf spot, 33, 209
 leaf and stem smut, 47, 210
 mosaic, 57, 209
 powdery mildew, 41, 209
- ringspot, 57, 140, 210
 root-knot, 75, 209
 root rot, 73, 208
 rust, 43, 45, 210
 soil drench, 208
 stem or crown rot, 62, 63, 208
- Columbo*, 230
 black mildew, 48, 231
 leaf spot, 33, 230
 rust, 45, 230
- Colutea*, 248
Comme'ina, 398
Compassplant; *see* *Silphium*
Compatibility chart, for pesticides, 446
Compost, 15, 16, 82
Compressed air sprayer, [93], [94]
Comptonia, 381; *see* *Sweetfern*
Coneflower; *see* *Rudbeckia*, *Prairie-coneflower*, *Purple coneflower*
Confederate-jasmine, 298
 black mildew, 48, 298
 leaf spot, 33, 298
 root rot, 73, 117, 298
 sooty mold, 48, 298
- Confederate-rose*; *see* *Hibiscus* (*arboreascens* forms)
- Conk*, [61]
- Construction damage*, 30
 Reducing damage to trees from construction damage, 32
- Control methods*, plant diseases
 air circulation, increase, 28, 33, 37, 39, 43, 47
 air humidity
 decrease, 28, 33, 39, 41, 45
 increase, 28
 alternate host, destroy or remove, 45, 84
 crop rotation, 12, 33, 41, 50, 53, 55, 62, 63, 67, 68, 70, 73, 75, 78, 83
 cropping practice, change, 83
 cultivating, 28, 70, 73, 83
 curing bulbs, corms, tubers, 39, 75
 insect and mite control, 33, 50, 53, 55, 57, 58, 60, 68, 70, 73, 83, 91
 mulch, wet, 39, 62
 nematocides, 12, 73, 77, 440-44
 plant disease-free seed, corms, bulb, tubers, nursery stock, 33, 41, 48, 50, 53, 55, 63, 64, 67, 73, 75, 78, 80, 82
 in disease-free soil, 53, 55, 62, 64, 67, 68, 73, 75, 77, 440-44
 hot water soaked seed, tubers, plants, 62, 78, 82
 at recommended time, 60, 82
 shallow, 83
 in sterile rooting medium, 62, 63, 67, 77, 78, 80, 83
 varieties, 33, 41, 43, 45, 48, 50, 53, 54, 55, 57, 64, 66, 73, 75, 82

- Control methods, plant diseases
 (continued)
 virus-free stock, 37, 57, 58
 in well-prepared, well-drained soil, 53, 62, 66, 70, 73, 75, 78, 82
 propagate from healthy stock, 39, 53, 55, 57, 58, 61, 63, 75, 77
 proper handling and storage of fruit and vegetables, 68, 73, 84
 pruning, 20, [21], [22], [23], 28, 37, 45, 47, 54, 64, 66, 73, 80, 83
 sanitation, 33, 37, 39, 41, 43, 47, 48, 50, 53, 55, 57, 58, 61, 62, 63, 64, 66, 67, 68, 70, 73, 75, 78, 80, 83
 seed, corm, bulb treatment, 50, 53, 55, 63, 67, 70, 73, 82
 soil drench, 62, 63, 73, 75, 77, 82, 92, 442
 fertility, balanced, 41, 62, 73
 fertilizing, 33, 50, 53, 55, 62, 64, 66, 73
 grade change, 30, [31], [32]
 pH, adjust, 50, 70, 75
 treatment, 437-44
 space plants, 33, 39, 41, 43, 62, 70, 73
 spray or dust program, 33, 35, 37, 39, 41, 43, 45, 47, 50, 57, 58, 60, 62, 64, 66, 68, 70, 73, 84-105
 stake trees and shrubs, 25, [26]
 temperature, increase, 45, 55
 water control, 33, 39, 45, 53, 62, 64, 65, 70, 73
 weed control, 39, 45, 47, 50, 53, 57, 58, 73, 78, 83
 winter protection, 28, [29]
 wound dressing, apply, 50, 64, 66, 70, 80
 treatment, 22, [23], [24], 25, 30, 50, 64, 65, 66, 70
 wounding, avoid, 50, 68, 70
Convallaria, 277
Conversion
 Fahrenheit to Centigrade and vice versa, 418
 gallon lots of spray, 422
 pesticide materials on small areas, 421
Convolvulus, 290
Cop-R-Nap, 449
Cooperia, 204
Coposil, 88
Copper
 deficiency, 18
 disease control, 33, 35, 39, 41, 47, 50, 70
 injury, 30
 naphthenate, 449
 spray, 18, 409
 sulfate, as disinfectant, 172, 342, 372
Copper, Fixed, fungicides, 88
 gallon lots, 422
Copper A Compound, 88
Copper 53, 88
Copper Hydro, 88
Copper Hydro Bordo, 88
Copper-tip; *see* *Gladiolus*
Copperleaf, 108
Coptis, 208
Coral-tree; *see* *Erythrina*
Coralbean; *see* *Erythrina*
Coralbells, 252
 leaf nematode, 61, 253
 leaf spot, 33, 252
 leafy gall, 66
 powdery mildew, 41, 252
 rust, 45, 252
 smut, 47, 253
 stem rot, 62, 253
Corallberry, 371; *see also* *Snowberry*
 berry rot, 70, 371
 canker, 63, 371
 gray-mold blight, 37, 70, 372
 leaf spot, 33, 371
 powdery mildew, 41, 372
 root rot, 73, 372
 rust, 43, 45, 371
 spot anthracnose or scab, 36, 70, 371
 stem gall, 372
Corydlyne, 215
 leaf spot, 33, 215
 root rot, 73, 215
Coreopsis, 181
 aster yellows, 59, 183
 curly-top, 60, 184
 leaf spot, 33, 181
 powdery mildew, 41, 183
 root-knot, 75, 134, 185
 root rot, 73, 183
 rust, 43, 184
 scab, 50, 138, 186
 southern blight, 62, 183
 stem rot, 62, 183
 verticillium wilt, 53, 141, 184
Coriander, 175; *see also* *Celery*
 anthracnose, leaf blight, 36, 175
 crown or stem rot, 62, 176, 177
 curly-top, 60, 136, 177
 fusarium wilt, 53, 176
 mosaic, 57, 176
 motley dwarf, 176
 root-knot, 75, 176
 root rot, 73, 177
 seed rot, damping-off, 62, 176
 seed treatment, 176
Coriandrum, 175
Corn, 190
 bacterial leaf spot, blight, 33, 193
 bacterial or Stewart's wilt, [55], 190, [191]
 black bundle, 193
 chlorosis, 16-18, 194
 crazy top, 38, [193]
 ear and kernel rot, 68, 192
 false-stripe, 57, 193
 fodder, 16
 leaf blight, 36, [192]
 leaf flea, 57, 193
 leaf spot, 33, 193
 light, effect on flowering, 27
 mosaic, 57, 193
 purple sheath spot, 193
 root nematode, 194
 root rot, 73, 191
 rust, 44, 45, 193
 seed rot, seedling blight, 62, 192
 seed treatment, 192, 430, 431
 smut, 47, [49], 191
 stalk rot, 68, 191, [192]
 stunt, 58, 193, 194
 witchweed (*Striga*), 194
Corn-marigold, 181; *see also* *Chrysanthemum*
 aster yellows, 59, 183
 damping-off, seed rot, 62, 183
 leaf spot, 33, 181
 seed treatment, 183
Corncockle, 169
 leaf spot, 33, 170
 root rot, 73, 169
 stem rot, 62, 169
Cornel, 211; *see also* *Dogwood*
 rust, 45, 213
 twig blight, 63, 213
Cornelian cherry; *see* *Dogwood*
Cornflower, 181; *see also* *Centaurea*
 aster yellows, 59, 183
 downy mildew, 40, 185
 fusarium wilt, 53, 184
 powdery mildew, 41, 183
 root-knot, 75, 134, 185
 root rot, 73, 183
 rust, 45, 184
 southern blight, 62, 183
 stem rot, 62, 183
 verticillium wilt, 53, 141, 184
 white-rust, 47, 186
Cornflower aster, 181; *see also* *Stokes-aster*
 downy mildew, 40, 185
 head blight (*Botrytis*), 37, 70, 185
 mosaic, 57, 184
Cornsalad, 403
 curly-top, 60, 403
 leaf spot, 33, 403
 powdery mildew, 41, 403
 root rot, 73, 208, 403
 stem rot, 62, 208, 403
Cornus, 211
Coronate, 86, 419
Coromerc, 89
Coromerc Liquid, 89
Corona 53, 88
Coronilla, 311
Corrosive sublimate, 85, 405; *see also* *Mercuric chloride*
Corydalis, 144
 downy mildew, 40, 145
 leaf spot, 33, 145
 root-knot, 75
 rust, 45, 144
Corylus, 142; *see also* *Filbert*, *Hazelnut*
Cosmos, 181
 aster yellows, 59, 183
 bacterial wilt, 55, 184
 curly-top, 60, 185
 fusarium wilt, 53, 184
 leaf spot, 33, 181
 light, effect on flowering, 27
 mosaic, 57, 184
 powdery mildew, 41, 183
 root-knot, 75, 134, 185

- root rot, 73, 183
 rust, 45, 184
 southern blight, 62, 183
 spotted wilt, 58, 184
 stem canker, blight, 36, 63, 185
 stem rot, 62, 183
Cotinus, 380
Cotoneaster, 114
 canker, 63, 116, 118
 collar rot, 62, 119
 fire blight, 66, 114
 hairy root, 68, 117
 leaf spot, blight, 33, 36, 116, 120
 powdery mildew, 41, 117
 root rot, 73, 117
 scab, 50, 115
 twig blight, 63, 118
Cotton root rot, 73
Cotton-rose; *see Hibiscus (arborescent forms)*
Cottonseed hulls, 16
Cottonwood, 337; *see also Poplar*
 canker, dieback, 63, 337
 catkin deformity, 337
 crown gall, 68, 117, 338
 ink spot, 33, 337
 leaf blister, yellow, 47, 337
 leaf spot, 33, 337
 mistletoe, 79, 338
 powdery mildew, 41, 337
 rust, 45, 337
 sooty mold, 48, 338
 wood rot, 64, 142, 337
County agent, 1, 26
 help by, 3, 39, 80, 83, 84, 108
County agricultural agent, 3
County extension director, 3
County extension office; *see also County agent*
 information, 12, 17, 85, 93
 soil tests, 16-17
 USDA bulletins, 25
Cover sprays, 424-25
Cowانيا, 356
 rust, 45, 357
Cowslip; *see Primrose*
Crab cactus; *see Cactus, Epiphyllum*
Crab Glyodin, 452
Crabapple, flowering, 114; *see also Apple*
 anthracnose, 36, 120
 black rot, 33, 63, 116
 blossom blight, 70, 114
 blotch, 63, 70, 117
 canker, 63, 118
 crown gall, hairy root, 68, 117
 dieback, 63, 116, 118
 fire blight, 66, 70, 114
 fruit rot or spot, 70, 118
 leaf spot, 33, 120
 powdery mildew, 41, 117
 root rot, 73, 117
 rust, 43, 45, 116
 scab, 50, 70, 115
 sooty mold, 48, 117
 spray schedule, 424-25
 wood rot, 64, 119
Crabgrass Killer and Turf Fungicide, 89
Crambe, 155
Cranberry-bush; *see Viburnum*
Cranesbill (*Geranium*), 194
 bacterial leaf spot, 33, 195
 botrytis leaf spot, 37, 195
 downy mildew, 40, 195
 leaf spot, 33, 194
 mosaic, 57, 195
 powdery mildew, 41, 195
 rhizome rot, 62, 195
 root-knot, 75, 195
 root nematode, 195
 root rot, 73, 195, 231
 rust, 45, 184, 195
 stem or crown rot, 62, 195
Crink duster, 100, [102], [103]
Crape-jasmine, 298
 leaf spot, mold, 33, 298
 root rot, 73, 117, 298
Crapemyrtle, 195
 black spot, 33, 195
 chlorosis, 16, 195
 leaf spot, blotch, 33, 36, 195
 powdery mildew, 41, 195
 root-knot, 75, 195
 root rot, 73, 195
 sooty mold, 48, 195
 thread blight, 195, 409
 tip blight, 36, 195
Crassula, 366
 anthracnose, 36, 366
 leaf nematode, 61, 366
 leaf spot, 33, 366
 root rot, 73, 366
 soil drench, 366
Crataegus, 114
Creeping Charlie; *see Loosestrife*
Creeping mint; *see Mint*
Creeping thyme; *see Thyme*
Crepis, 181
Cress; *see Garden cress*
Crinkle, 55
Crinum, 204
 leaf scorch or red spot, 36, 205
 leaf spot, 33, 207
 mosaic, 57, 205
Crocanthemum, 381
Crocospomia; *see Gladiolus*
Crocus, 232
 bacterial scab, 33, 50, 234
 blind buds, 235
 corm rot, 75, 232
 mosaic, 57, 234
Crop rotation, 12
 in disease control, 12, 33, 41, 50, 53, 55, 62, 63, 67, 68, 70, 73, 75, 78, 83
Cross vine, 141
Crotalaria, 311
 anthracnose, 35, 314
 fusarium wilt, 53, 311
 gray-mold blight, 37, 314
 leaf spot, 33, 314
 mosaic, 55, 312
 powdery mildew, 41, 312
 root-knot, 75, 314
 root rot, 73, 311, 312
 seed treatment, 312
 soil drench, 311
 stem canker, 63, 312
 stem rot, 62, 312, 313
Croton, 196
 anthracnose, 36, 196
 bacterial wilt, 55
 leaf and stem spot, 33, 196
 root nematode, 196
 root rot, 73, 196
Crowberry, rust, 43
Crowfoot; *see Buttercup*
Crown gall, 68, [69]
 paint, 70, 322, 407
Crown imperial; *see Fritillary*
Crown rot, 12, [62]
Crown-of-thorns; *see Spurge*
Crownbeard, 181
 downy mildew, 40, 185
 leaf spot, 33, 181
 powdery mildew, 41, 183
 root-knot, 75, 134, 185
 root rot, 73, 183
 rust, 45, 184
 stem spot, 62, 183
Crownvetch, 311; *see also Pea*
 root-knot, 75, 314
Crucifers, 154
Cryptophytum, 253
Cryptogramma, 223
Cryptomeria, 259
 leaf blight, 36, 260
 leaf spot, 33, 260
 twig blight, 63, 260
Cucumber, 196; *see also Cucurbit*
 angular leaf spot, 33, 197
 anthracnose, 36, 196
 aster yellows, 59, 200
 bacterial soft rot, 68, 200
 bacterial spot, 33, 197, 201
 bacterial wilt, [55], 197
 blossom blight, 70, 201
 chlorosis, 16-18, 201
 crown gall, 68, 201
 curly-top, 60, 199
 damping-off, 62, 200
 downy mildew, [40], 199
 fruit rot, 70, 172, 200
 fusarium wilt, 53, 198
 gray-mold rot, 37, 200
 gummy stem blight, 63, 200
 leaf blight, 36, 197
 leaf spot, 33, 197
 mosaic, 57, 199
 powdery mildew, 41, 199
 ringspot, 58, 200
 root-knot, 75, 200
 root rot, 73, 132, 200
 scab, 50, [51], 197
 seed treatment, 196, 197, 427, 430, 431
 seedbed spray, 200
 southern blight, 62, 200
 stem or foot rot, 62, 200
 verticillium wilt, 53, 200
 watery soft rot, 70, 200
 web blight, 134, 201
Cucumbertree; *see Magnolia*
Cucumis, 196
Cucurbit, 196
 angular leaf spot, 33, 197
 anthracnose, 35, 70, 196
 aster yellows, 59, 200
 bacterial soft rot, 68, 70, 200
 bacterial spot, 33, 35, 197, 201
 bacterial wilt, [55], 197
 blossom blight, 70, 201
 blossom-end rot, 70, 201, 390
 boron deficiency, 17, 201

- Cucurbit (*continued*)
 chlorosis, 16–18, 201
 crown gall, 68, 201
 curly-top, 60, 199
 damping-off, 16, 62, 198, 200
 downy mildew, [40], 199
 fruit rot, 68, 70, 172, 198, 200
 fusarium wilt, [52], 198
 gray-mold rot, 37, 200
 gummy stem blight, 63, 200
 leaf blight, 36, 37, 197
 leaf spot, 33, 35, 197, [198], 200
 mosaic, 57, 199
 powdery mildew, 41, [198], 199
 ringspot, 57, 200
 root-knot, 75, [77], 200
 root nematode, 200
 root rot, 73, 132, 200
 scab, 50, [51], 197
 seed rot, 200
 seed treatment, 196, 197, 427, 430, 431
 seedbed treatment, 200
 sooty mold, 48, 201
 southern blight, 62, 200
 stem rot, 62, 63, 200
 stem streak, 63, 200
 storage rot, 70, 200
 2,4,D injury, 201, 237
 verticillium wilt, 53, 200
 watery soft rot, 70, 200
 web blight, 134, 201
- Cucurbita, 196
 Cultivating, 28
 Cultural practices, 14–32
 air humidity, control, 28, 33
 The Care and Feeding of Garden Plants, 14
 cultivating, shallow, 28
 fertilizing, 18–20, [20], [21]
 help on, 8
 light, 27–28
 loosening soil, 16
 mulching, 28
 nutrient deficiencies, 17–18
 organic matter, 16
 pesticides, precautions in using, 30
 planting, 14–15
 pruning, 20 [21], [22], 23
 resistant varieties, 33
 rotation, 33
 sanitation, 33
 soil, 15–17
 drainage, 25–27
 staking trees and shrubs, 25, [26]
 sunscorch, 28
 temperature, 28
 tree wound treatment, 22, [23], [24], 25
 watering, 15, 27, 28
 winter protection, 28, [29]
- Culversroot, 373
 leaf spot, 33, 373
 powdery mildew, 41, 373
 root nematode, 373
 root rot, 73, 231, 373
 rust, 45, 374
 stem rot, 62, 373
- Cunila, 362
 Cuphea; *see* Cigarflower
- Cup-plant; *see* Silphium
 Cypressus, 259
 Cuprinol Green No. 10, 449
 Cuprocide, 88
 Curly-top, [60]
 Currant, 201; *see also* Flowering currant
 anthracnose, 36, 201, [202]
 cane blight, 63, 202
 canker, 63, 202
 chlorosis, 16, 285
 collar rot, 62, 203
 dieback, 63, 202
 downy mildew, 40, 203
 fruit spot, rot, 37, 70, 202
 gray-mold blight, 37, 202
 leaf spot, 33, 201, [202]
 mosaic, 57, 203
 powdery mildew, 41, 202
 root rot, 73, 117, 203
 rust, 43, 45, 202
 spray schedule, 424–25
 thread blight, 203, 409
 verticillium wilt, 53, 129, 203
- Curuba; *see* Sicana
- Cushion-pink, 169; *see also* *Silene*; Pinks, garden; Mullein-pink
 damping-off, 62, 169
 downy mildew, 41, 171
 flower or anther smut, 47, 171
- Cuttings, in transmitting viruses, 11
- Cyclamen, 203
 bacterial soft rot, 68, [202], 203
 fusarium wilt, 53, 204
 gray-mold blight, 37, 70, 203
 leaf and bud blight, 36, 203, 204
 leaf nematode, 61, 204
 leaf spot, 33, 204
 light requirements of, 28
 petal spot or rot, 70, 203
 root-knot, 75, 203
 root nematode, 204
 root rot, 73, 204
 seedling blight, damping-off, 62, 204
 stunt, 203
 tuber rot, 62, 68, 203
 white mold, 204
- Cyconia, 114
 Cymbidium, 302
 Cynara, 272
 Cynodon, 265
 Cynoglossum, 288
 Cyperus, 403
 Cyphomandra, 389
 Cypress, 259; *see* Chamaecyparis for Hinoki cypress and Sawara-cypress
 canker, dieback, 63, 260
 crown gall, 68, 117, 260
 mistletoe, 79, 261
 needle cast, 36, 260
 nursery or juniper blight, 36, 260
 pruning, 22
 root nematode, 261
 root rot, 73, 117, 260
 rust, 45, 259
 seedling blight, 62, 260
 twig blight, 63, 260
- wood rot, 64, 142, 260
 Cypressvine, 290
 root-knot, 75, 291
 root rot, 73, 291
 rust, 45, 290
 white-rust, 47, 158, 290
- Cyprex, 251, 317, 386, 406
 Cypripedium, 302
 Cyrilla, 153
 Cyrtomium, 223
 Cyst nematode, 75
 Cystopteris, 223
 Cytisus, 151
- D**
- Daffodil, 204
 bacterial streak, stem rot, 35
 basal rot, 75, [76], 204
 bulb nematode, 77, 78, 205
 bulb rot, 75, [76], 204
 bulb soak, 205, 206, 429, 430, 434
 fire, neck rot, 205
 flower spot, 70, 205
 flower streak, 57, 205
 gray-mold blight, 38, 70, 205
 leaf blight, 36, 205
 leaf scorch, 36, [206]
 leaf spot, 33, 207
 mosaic, 57, 205
 root and crown rot, 62, 73, 204
 root nematode, 205, 207
 smoulder, 36, 75, [206]
 stem, leaf, and bulb nematode, “ring disease,” 61, 205, [206]
 white mold or ramularia blight, 36, [206], 207
 white streak or paper tip, 205
 yellow dwarf, 207, 301
 yellow stripe, 57, 205
- Dahlia, 181
 aster yellows, 59, 183
 bacterial soft rot, 67, 183, 186
 bacterial wilt, 55, 184
 blossom blight, 70, 184, 185
 bulb nematode, 78, 186
 crown gall, 68, 186
 fasciation, 67, 186
 fusarium wilt, 53, 184
 gray-mold blight, 37, 185
 hopperburn, 186
 leaf blight, 36, 181
 leaf nematode, 61, 185
 leaf smut, 50, 186
 leaf spot, 33, 181
 mosaic, 57, [59], 184
 powdery mildew, 41, 183
 ringspot, oakleaf disease, [58], 184
 root-knot, 75, [77], 134, 185
 root rot, 73, 183
 scab, 50, 138, 186
 southern blight, 62, 183
 spotted wilt, [58], 184
 stem or cutting rot, 62, 183
 storage or tuber rot, 67, 70, 172, 186
 stunt, dwarf, [59], 183, 184
 verticillium wilt, 53, 141, 184

- Dahoon, 245; *see also* Holly
black mildew, 48, 245
sooty mold, 49, 245
- Daisy
African; *see* *Arctotis*, *Gazania*
blue; *see* Blue daisy
English; *see* English daisy
giant; *see* *Chrysanthemum*
Michaelmas; *see* *Aster*, perennial
oxeye; *see* *Chrysanthemum*
painted; *see* *Pyrethrum*,
 Chrysanthemum
Paris; *see* Marguerite
Shasta; *see* *Chrysanthemum*,
 Shasta daisy
Swan River; *see* Swan River
 daisy
Transvaal; *see* Transvaal
 daisy
turfing; *see* *Matricaria*
- Damesrocket, 155; *see also*
 Cabbage
clubroot, 75, 156
downy mildew, 40, 157
mosaic, flower breaking, 57,
 159
verticillium wilt, 53, 160
white-rust, 47, 158
- Damping-off, 37, 62
control, 82
- Dangleberry; *see* Huckleberry
- Daphne, 207
anthracnose, 36, 207
canker, 63, 207
dieback, 63, 207
fusarium wilt, 53, 208
leaf spot, 33, 207
mosaic, 57, 207
stem, crown, or collar rot,
 wilt, 62, 207, 208
twig blight (*Botrytis*), 37, 207
verticillium wilt, 53, 208
winter injury, 28, 208
- Dasheen, 162; *see also* Elephants-ear
bacterial soft rot, 68, 70, 162
tuber rot, 70, 162
- Datura, 389; *see also* Tomato
aster yellows, 58, 394
bacterial wilt, 55, 395
early blight, 33, 389
fruit rot, pod blight, 70, 390
leaf roll, 397
leaf spot, 33, 390
mosaic, 57, 392
ringspot, 58, 394
root rot, 73, 396
rust, 43, 397
southern blight, 62, 396
spotted wilt, 58, 393
- Daucus, 171
- Day-neutral plants, 27
- Dayflower, 398
leaf spot, 33, 398
root-knot, 75, 398
rust, 45, 398
- Daylily, 244
blight, 244
gray-mold blight, 37, 244
leaf spot, leaf blight, 33, 36,
 244
root-knot, 75, 244
root nematode, 244
- root rot, 73, 231, 244
russet spot, 244
winter or frost injury, 28, 244
- DBCf, 324, 444
- D-D
disinfesting soil, 70, 77, 440
 home garden, 440
precautions, 442
trade names, 442, 450
- D-Soil Fumigant, 442, 450
- DDT, 33, 50, 55, 58, 60, 68, 70,
 73, 83
injury, 30
multipurpose mixes, 91
- Dealer, garden supply, 3
- Decumaria, 252
leaf spot, 33, 252
- Deergrass, 208
leaf spot, 33, 208
- Deficiency, nutrient, 17-18
oxygen, 26
- Delisle ceanothus; *see* New Jersey-tea
- Delphinium, 208
bacterial collar rot, soft crown
 rot, 55, 68, 208
black leaf spot or blotch, 33,
 [35], 36, 209
“blacks,” 211
chlorosis, 16, 210
collar rot, 62, 208
crown gall, 68, 140, 209
curly-top, 60, 210
damping-off, 62, 209
flower blight, 70, 208, 209,
 210
fusarium wilt, 53, 209
gray-mold blight, 37, 70, 208,
 209, 210
“greens,” 59, 209
leaf spot, 33, 209
leaf and stem nematode, 61,
 210
leaf and stem smut, 47, 210
mosaic, 57, 209
powdery mildew, 41, 209
ringspot, 58, 209, 210
root-knot, 75, 209
root nematode, 209
root rot, 73, 208
rust, 43, 45, 210
seed rot, 209
seed treatment, 208, 429, 433
soil drench, 208, 209
southern blight, 62, 208
spotted wilt, 58, 140, 209
stem canker, 63, 208
stem rot, 62, 68, 208
verticillium wilt, 53, 209
white smut, 50, 210
yellows, 59, 183, 209
- Delsan A-D Seed Protectant,
 419, 430
- Dendrobium, 302
- Dendromecon, 338
- Dennstaedia, 223
- Dentaria, 155
- Desert-willow, 174
 damping-off, 62, 175, 333
leaf spot, 33, 174
root rot, 73, 117, 175
- Desertplume, 155; *see also* Cabbage
leaf spot, 33, 158
- rust, 45, 160
- Desmanthus, 151
- Deutzia, 252
leaf spot, 33, 252
root-knot, 75, 252
root rot, 73, 231, 253
- Devilclaw; *see* Proboscisflower
- Devilwood; *see* Osmanthus
- Dewberry, 347; *see also* Boysenberry, Raspberry
anthracnose, 36, 347
black mildew, 48, 350
cane blight, 63, 348
cane and crown gall, hairy
 root, 68, 348
canker, dieback, 63, 348
downy mildew, 40, 351
dwarf, 58, 348
fruit rot, spot, or mold, 37,
 70, 349
gray-mold blight, 37, 70, 349
leaf curl, 57, 348
leaf spot, 33, 350
mosaic, 57, 348
orange rust, 45, 349
powdery mildew, 41, 350
root rot, 73, 117, 350
sooty blotch, 48, 350
spot anthracnose, 36, 347
spray schedule, 424-25
spur blight, 63, 348
verticillium wilt, 53, 350
winter injury, 28, 350
yellow rust, 45, 350
- Dexon, 269
- Diagnosis of disease; *see* Disease
- Dianthus, 169; *see also* Carnation, Pinks, garden, Sweetwilliam
 anther smut, 47, 171
 aster yellows, 59, 170
- Diazinon, 299
- 1,2-dibromo-3-chloropropane, 444
- 1,2-dibromoethane, 442
- Dicentra; *see* Bleeding heart
 Dutchmans-breeches, Squirrelcorn
- Dichalone
gallon lots, 422
seed, bulb treatment, 86, 419,
 430
- smog prevention, 29
- soil drench, 86, 419
- spray or dust, 39, 86, 419
- trade names, 86, 419
- tree wound dressing, 386
- uses, 86, 419
- Dichloro-compounds
2,3-dichloro-1,4-naphthoquinone, 86, 419
0-2,4-dichlorophenyl o,o-diethyl phosphorothioate, 444
1,3-dichloropropene-1,2-dichloropropane, 89, 442
- Didiscus, 175
- Dieback, 12, 63
- Dieffenbachia, 162
anthracnose, 36, 163
bacterial leaf spot, 33, 163
bacterial soft rot, 68, 162
bacterial stem rot, 55, 163
cane soak, 162, 429, 433

- Dieffenbachia (continued)**
- leaf spot, 33, 163
 - root rot, 73, 162
 - stem rot, 55, 62, 162
- Dieldrin, 53, 68, 83
- Digitalis, 368
- Dill, 175; *see also* Celery
- aster yellows, 59, 176
 - curly-top, 60, 136, 177
 - damping-off, seed rot, 62, 176
 - fusarium wilt or yellows, 53, 176
 - leaf spot, 33, 175
 - mosaic, 57, 176
 - motley dwarf, 176
 - root-knot, 75, 176
 - root nematode, 177
 - root rot, 73, 177
 - seed treatment, 176, 431
 - stem spot, rot, 176
- Dimethyltetrahydro-1,3,5,2H-thiadiazine-2-thione, 443
- Dimorphotheca, 181
- Dinitro injury, 30
- Dioscorea, 413
- Diospyros, 326
- Dipsacus, 388
- Dirca, 272
- Disease; see also Control**
- methods
 - causes, 7
 - classification, 6
 - control, 1, 81-106
 - help on, 3
 - defined, 6
 - diagnosis, 1, 5, 14
 - help on, 3
 - loss in the United States, 6
 - by nematodes, 12
 - types of, 7, 33-80
- Dithane M-22, 86, 419
- Dithane Z-78, 87, 419
- Dittany, 362
- leaf spot, 33, 362
 - rust, 45, 362
- Dockmackie; *see* Viburnum
- Dodder, [80]
- Dodecatheon, 344
- Dodine, 251, 317, 386, 406
- Doggett-Pfeil Company, 106
- Dogstooth-violet, 221; *see also* Erythronium
- botrytis blight, 37, 221
 - leaf smut, 47, 221
 - rust, 45, 221
- Dogwood, 211
- canker, dieback, 63, 213
 - collar rot, bleeding canker, 63, 211, [212]
 - cowpea gall, 68, 117, 213
 - felt fungus, 213, 241
 - gray-mold blight, flower blight, 37, 70, 213
 - leaf scorch, 28, 213
 - leaf spot, 33, 213, [214]
 - mistletoe, 79, 213
 - powdery mildew, 41, 213
 - root-knot, 75, 213
 - root nematode, 213
 - root rot, 73, 117, 213
 - rust, 45, 213
 - sooty mold, black mildew, 48, 117, 213
- spot anthracnose, 36, 70, 213, [214]
- sunsald, 28, 119, 213
- thread blight, 213, 409
- twig blight, 63, 213
- 2,4-D injury, 213, 237
- verticillium wilt, 53, 213, 284
- wood rot, 64, 142, 213
- Dolichos, 311
- Dorlone, disinfesting soil, 77, 443
- precautions, 443
- Dormant spray, 47, 425
- oil injury, 30
- Doconicum, 181
- Douglas-fir, 330
- bacterial gall, 68, 334
 - brown felt blight, 334
 - canker, dieback, 63, 331
 - damping-off, 62, 333
 - gray-mold blight, 37, 333
 - leaf blight, 36, 330
 - mistletoe, 79, 333
 - needle cast, 36, 330
 - root nematode, 323, 333
 - root rot, 73, 117, 333
 - rust, 43, 45, 332
 - seed rot, 333
 - seed treatment, 333
 - seedling blight, 62, 333
 - snow blight, 334
 - soil drench, 333
 - twig blight, 63, 330, 331
 - wood rot, 64, 142, 330
- Dow Chemical Company, The, 106
- Dowcide B, 299
- Dowfume G, 443
- Dowfume G-40, 443
- Dowfume MC-2, 443
- Dowfume W-40, 442
- Dowfume W-85, 442
- Downy mildew, 39, [40]
- Downy pinxterbloom; *see* Azalea
- Doxantha, 399
- root rot, 73, 399
- Draba, 155
- Dracaena, 215
- anthracnose, 36, 215
 - chlorosis, 16, 215
 - gray-mold blight, 37, 215
 - leaf spot, 33, 215
 - root-knot, 75, 215
 - root nematode, 215
 - root rot, 73, 215
 - stem rot, 62, 215
 - tip blight, 36, 215, [216]
- Dracocephalum, 362
- Dragonhead, 362
- downy mildew, 40, 363
 - leaf spot, 33, 362
 - southern blight, 62, 208, 363
- Dragonroot; *see* Jack-in-the-pulpit
- Drainage, soil, 25-27
- Dropwort; *see* Meadowsweet
- Dryopteris, 223
- Duchesnea, 356
- E. I. du Pont de Nemours & Company, 86, 87, 89, 106, 419
- Du Pont Spreader-Sticker, 104
- Dusters, 100-105
- bellows, 100
- crank, 100, [102], [103]
- knapsack, 100, [103]
- bellows, 100
 - rotary-fan, 104
- maintenance of, 104
- plunger-type, 100, [101]
- power, 104, [105]
- rotary-fan, 100, 104
- Dusting**
- advantages and disadvantages, 92
 - coverage, 91
 - equipment, 100-105
 - multipurpose mixes, 91
 - precautions, 89-90
 - tips, 90-91
 - vs. spraying, 92
- Dusts, multipurpose mixes, 91
- Dusty-miller; *see* Artemesia, Centaurea, Senecio**
- Dutchmans-breeches, 144
- downy mildew, 40, 145
 - rust, 45, 144
- Dutchmans-pipe; *see* Aristochia
- Dwarf cornel; *see* Dogwood
- Dwarf lace plant; *see* Silver lacevine
- Dwarf mistletoe, [79]
- Dwarf (virus), 58, [59]
- Dyer's greenweed; *see* Wood-waxen, Broom
- Dyrene, 451
- Dyschoriste, 188
- rust, 45, 188

E

- Eastern States Farmers' Exchange, 89, 106
- Echeveria, 366
- root-knot, 75, 366
 - rust, 45, 366
- Echinacea, 181
- leaf spot, 33, 181
 - mosaic, 57, 184
 - root rot, 73, 183
- Echinocactus, 161; *see also* Cactus
- anthracnose, 36, 161
 - black leaf spot, 33
 - leaf scorch, 36, 161
 - root rot, 73, 161
 - scald, 36, 161
 - stem rot, 62, 161
- Echinocystis, 196
- Echinos, 181
- EDB
- disinfesting soil, 70, 77, 89, 442
 - home garden, 440
 - precautions, 442
 - trade names, 442
- Edco Nemadrench, 444
- Eelworms; *see* Nematodes
- Eggplant, 389; *see also* Tomato
- anthracnose, 36, 390
 - aster yellows, 59, 394
 - bacterial soft rot, 68, 70, 390, 391
 - bacterial spot, 33, 391
 - bacterial wilt, 55, 395
 - curly-top, 60, 394

- damping-off, 62, 395, 396
 downy mildew, 40, 396
 early blight, 36, 389
 fruit spot or rot, 68, 70, 390, 391, 396
 fusarium wilt, 53, 394
 gray leaf spot, 33, 390
 gray-mold rot, 37, 73, 390
 late blight, 36, 389
 leaf spot, 33, 390
 mosaic, 57, 392
 phytophthora blight, 36, 396
 powdery mildew, 41, 397
 root-knot, 75, 395
 root nematode, 395
 root rot, 73, 396
 rust, 45, 397
 scab, 50, 339, 397
 seed rot, 395
 seed treatment, 392, 428, 432
 seedbed treatment, 395
 septoria leaf spot, 33, 389
 southern blight, 62, 396
 spotted wilt, 58, 393
 stem or collar rot, 62, 63, 395
 streak, 392
 verticillium wilt, 53, [54], 395
 web blight, 134, 397
 yellows, 59, 394
- Elaeagnus, 361
- Elder, 371
 canker, twig blight, dieback, 63, 371
 leaf scorch, 28, 372
 leaf spot, 33, 371
 powdery mildew, 41, 372
 root rot, 73, 372
 rust, 45, 371
 spot anthracnose, 371
 thread blight, 372, 409
 trunk canker, 63, 211, 371
 verticillium wilt, 53, 372
 web blight, 134, 372
 wood rot, 64, 211, 371
- Elecampane, 181; *see also* Inula
 powdery mildew, 41, 183
 rust, 45, 184
- Electrical injury, 32
- Elephant's-ear, 162
 bacterial soft rot, 68, 162
 root-knot, 75, 162
 root rot, 73, 162
 southern blight, 62, 162
 tuber rot, 70, 162
- Elgetol
 control rust, 125
 crown gall treatment, 70, 407
 injury, 30
 tree wound dressing, 66, 315
- Elm, 217
 anthracnose, 36, 218
 black leaf spot, 33, 218, [219]
 bleeding canker, 63, 135, 220, 285
 canker, dieback, 63, 218
 chlorosis, 16, 220, 285
 dothiorella (*Cephalosporium, Deuterophoma*) wilt, 218
 dutch elm disease (*Ceratosphinctes, Ceratostomella, Ceratocystis* wilt), [217]
 freezing injury, 28, 219
 frost crack, 28, 219
- leaf blister, 47, 220
 leaf scorch, 28, 220
 leaf spot, 33, 218
 lightning injurv, 32
 mistletoe, 79, 220
 mosaic, mottle-leaf, witches'-broom, 57, 219
 phloem necrosis, 218
 powdery mildew, 41, 220
 root-knot, 75, 220, 323
 root nematode, 220
 root rot, 73, 117, 219
 seedling blight, damping-off, seed rot, 62, 220, 333
 sooty mold, 48, 220
 sunscald, 28, 219
 thread blight, 220, 409
 twig blight, 63, 218
 2,4-D injury, 220, 237
 verticillium wilt, 53, 218
 virus scorch, 220
 wetwood or slime flux, 218, [219]
 winter injury, 28, 219
 wood, heart rot, 64, 142, 219
- Emilia, 181
 mosaic, 57, 184
 root-knot, 75, 134, 185
 root nematode, 186
 rust, 45, 184
 spotted wilt, yellow spot, 58, 184
 stem rot, 62, 183
- Emmi, 205
- Empresstree; *see* Paulownia
- Encelia, 181
 root-knot, 75, 134, 185
 rust, 45, 184
- Endive, 272; *see also* Chicory
 anthracnose, 36, 274
 bacterial rot, 33, 68, 70
 bacterial soft rot, 68, 70, 272
 bottom rot, 70, 272
 downy mildew, 40, 273
 gray-mold blight, rot, 37, 70, 273
 mosaic, 57, 273
 powdery mildew, 41, 274
 rust, 45, 274
 seed treatment, 274, 431
 spotted wilt, 58, 275
 verticillium wilt, 53, 275
 watery soft rot, 70, 272
- Engelmann ivy; *see* Boston ivy, Grape
- English daisy, 181
 aster yellows, 59, 183
 crown rot, 62, 183
 gray-mold blight, 37, 185
 leaf spot, 33, 181
 root-knot, 75, 134, 185
 root rot, 73, 183
- English ivy; *see* Ivy
- Entomologist, extension, 3, 4, 83
- Epidendrum, 302
- Epigaea, 243
- Ephyllium, 161; *see also* Cactus
 corky scab, glassiness, 28, 161
- Episicia, 109
- Epsom salts, 18
- Equipment
 dusting, 100–105
 spraying, 92–99
- Equivalent volumes, liquid, 420
- Eradicative seed treatment, 427–36
- Eranthemum, 188
 leaf spot, 33, 188
 oedema, 28, 189
- Eremochloa, 265
- Erica, 243
- Erigeron, 181
 aster yellows, 59, 183
 downy mildew, 40, 185
 leaf gall, 33, 181
 leaf spot, 33, 181
 mosaic, 57, 184
 powdery mildew, 41, 183
 rust, 43, 45, 184
 spotted wilt, 58, 184
 stem rot, 62, 183
 verticillium wilt, 53, 141, 184
 white smut, 50, 186
- Eriobotrya, 114
- Erodium, 194
- Eryngium, 175
 leaf spot, 33, 175
 root rot, 73, 177
 seed rot, damping-off, 176
 seed treatment, 176
 stem rot, 62, 176
 white or leaf smut, 50, 177
- Eryngio; *see* Eryngium
- Erysimum, 155; *see also* Wallflower, western
 clubroot, 75, 156
 downy mildew, 50, 157
 mosaic, 57, 159
 powdery mildew, 41, 160
 rust, 45, 160
 spotted wilt, 58, 159
 white-rust, 47, 158
- Erythrina, 248
 leaf spot, 33, 249, 286
 root-knot, 75, 249, 323
 root rot, 73, 117, 248
 thread blight, 249, 409
 verticillium wilt, 53, 249, 284
- Erythronium, 221
 black spot, 33, 221
 botrytis blight, 37, 221
 leaf blight, 36, 221
 leaf smut, 47, 221
 leaf spot, 33, 221
 rust, 43, 221
- Escarole, 272; *see also* Chicory
 bacterial rot, 33, 68, 274
 bacterial soft rot, 68, 70, 272
 bottom rot, 70, 272
 damping-off, 62, 274
 downy mildew, 40, 273
 gray-mold blight, rot, 37, 273
 seed treatment, 274, 431
 spotted wilt, 59, 275
- Eschscholtzia, 338
- Ethylene injury, 29
- Eucharis, 204
- Euonymus, 143
 anthracnose, 36, 144
 canker, dieback, 63, 144
 crown gall, 68, 144
 leaf scab, 50, 144
 mosaic, infectious variegation, 57, 144

Euonymus (*continued*)
 powdery mildew, 41, 143
 root-knot, 75, 144
 root nematode, 144
 root rot, 73
 thread blight, 144, 409

Eupatorium, 181
 aster yellows, 59, 183
 downy mildew, 40, 185
 fusarium wilt, 53, 184
 gray-mold blight, 37, 38, 185
 leaf spot, 33, 181
 powdery mildew, 41, 183
 root-knot, 75, 134, 185
 root rot, 73, 183
 rust, 45, 184
 stem rot, 62, 183
 white-rust, 47, 186
 white smut, 50, 186

Euphorbia; *see* Poinsettia, Spurge

European cranberry-bush, 404; *see also Viburnum*
 bacterial leaf spot, 33, 404
 dieback, 37, 64, 404, 405
 downy mildew, 40, 404
 gray-mold blight, 37, 404
 powdery mildew, 41, 404

Eustoma, 230

Evening campion (*Lychnis*), 169; *see also Carnation, Silene*
 leaf spot, 33, 170
 root rot, 73, 169
 rust, 45, 169
 southern blight, 62, 169

Evening-primrose, 221
 downy mildew, 40, 221
 leaf gall, 221
 leaf spot, 33, 221
 mosaic, 57, 221
 powdery mildew, 41, 221
 root rot, 73, 221
 rust, 45, 221
 stem nematode, 61, 221, 328

Evergreen
 fertilizing, 19
 planting, 14
 pruning, 22
 watering, 27, 29
 winter protection, 29

Everlasting, 181
 downy mildew, 40, 185
 leaf spot, 33, 181
 white-rust, 47, 186

Everlasting pea; *see Sweetpea*

Exacum, 230
 botrytis blight, stem canker, 37, 63, 230
 damping-off, 62, 231

Experiment stations, listing of, 4-5

Extension office; *see County extension office*

F

F & B Lime Sulphur Solution, 454

Faesy & Besthoff, Incorporated, 106

Fagus, 135

Fahrenheit, conversion to Centigrade, 418
Fall-daffodil, 204; *see also Daffodil*
 leaf scorch or red spot, 37, 205

False-acacia; *see Locust*
False-camomile; *see Boltonia, Camomile, Matricaria*
False-dragonhead, 362
 crown or stem rot, 62, 208, 363
 downy mildew, 40, 363
 leaf spot, 33, 362
 rust, 45, 362
 southern blight, 62, 208, 363

False-garlic, 299; *see also Onion*
 anthracnose, 37, 301
 mosaic, 57, 301
 rust, 45, 302

False-indigo, 222
 leaf spot, 33, 222

powdery mildew, 41, 222
 root rot, 73, 222

rust, 45, 222

False-mallow, 246

leaf spot, 33, 246

root rot, 73, 247

rust, 43, 246

False-mesquite, 164

rust, 45, 164

Farewell-to-spring; *see Godetia*

Farm adviser, 3

Farmrite M-53 Fixed Copper, 88

Fasciation, 66, [67]

Fawn lily; *see Erythronium*

Feijoas, 292

fruit rot, 38, 70, 292

root rot, 73, 292

spot anthracnose, 37, 292

thread blight, 293, 409

Felicia; *see Blue daisy*

Fenac, 194

Fendlera, 252

rust, 43, 45, 252

Fennel, 175

aster yellows, 59, 172, 176

bacterial soft rot, 68, 176

blackheart, 176

curl-top, 60, 136, 177

damping-off, 62, 176

downy mildew, 40, 173, 177

gray-mold rot, 38, 176

leaf spot, 33, 175

mosaic, 57, 176

root-knot, 75, 176

root rot, 73, 177

seed treatment, 176, 431

stem rot, canker, 62, 63, 176

Ferbam

control of iron deficiency, 352, 379

gallon lots, 422

in multipurpose mixes, 86, 91

smog prevention, 29

soil drench, 62, 82, 85, 86, 92, 419

spray or dust, 39, 47, 86, 419

trade names and distributors, 86, 419

in tree wound dressing, 386

uses, 86, 419

Fermate Ferbam Fungicide, 86, 419

Ferns, 223; *see also Asparagus fern*
 anthracnose, tip blight, of *Nephrolepis*, *Pteris*, 37, 223

bacterial leaf spot, of *Asplenium*, 33

inflorescence smut, of *Osmunda*, 47, 224

leaf blister or gall, of *Cystopteris*, *Dryopteris*, *Onclea*, *Osmunda*, *Polystichum*, *Pteretis*, 47, 223

leaf nematode, *Asplenium*, *Blechnum*, *Dryopteris*, *Polypodium*, *Polylystichum*, 61, [223]

leaf spot or blight, of *Adiantum*, *Asplenium*, *Athyrium*, *Camptosorus*, *Dryopteris*, *Nephrolepis*, *Ophioglossum*, *Osmunda*, *Polypodium*, *Polylystichum*, *Pteridium*, 33, 37, 223

light requirements of, 28

low humidity, leaf scorch, 28, 223

plant soak, 223, 429, 433

rust, of *Athyrium*, *Camptosorus*, *Cryptogramma*, *Cystopteris*, *Dennstaedtia*, *Dryopteris*, *Nephrolepis*, *Onclea*, *Osmunda*, *Pellaea*, *Polypodium*, *Polylystichum*, *Pteretis*, *Pteridium*, *Woodwardia*, 44, 45, 223

soil moisture, 16

sooty mold, black mildew, 48, 224

tar spot, of *Dryopteris*, *Polylystichum*, *Pteretis*, *Pteridium*, 33, 223

Ferocactus; *see Echinocactus*

Ferric dimethylidithiocarbamate, 86, 419

Ferro Copper Naththenate, 5%, 449

Ferrous sulfate; *see Iron sulfate*

Fertilizing plants, 18, 19, [20], [21]

Fescue, *Fescue grass*, 265; *see also Bluegrass*

anthracnose, 37, 265

brown patch, 267

damping-off, 271

dollar spot, 267

fairy ring, 268

foot rot, 265

fusarium patch, 269

leaf blight, 37, 265

leaf spot, 33, 265

melting-out, 265

powdery mildew, 41, 266

red thread, 270

root nematode, 269

root rot, 265

rust, 45, 266

seed treatment, 271

slime mold, 267

smut, 47, 270

snow scald, 268

stem or culm rot, 62, 265

- tar spot, 33, 265
Festuca, 265
Fetterbush; *see Lyonia*
Feverfew, 181; *see also Chrysanthemum*
 damping-off, seed rot, 62, 183
 powdery mildew, 41, 183
 root rot, 73, 183
 seed treatment, 183
 stem rot, 62, 156, 183, 185
 white-rust, 47, 186
Ficus, 224
Fig, 224
 anthracnose, 37, 224
 canker, dieback, 38, 63, 118, 224
 chlorosis, 16, 225, 407, 409
 crown gall, 68, 117, 224
 fruit spot or rot, 38, 70, 224
 fusarium wilt, 53, 225
 leaf blotch, blight, 37, 224
 leaf spot, 33, 224
 limb blight, 63, 224
 mosaic, 57, 225
 root-knot, cyst nematode, 75, 224
 root rot, 73, 117, 224
 rust, 45, 224
 rusty leaf, 224
 sooty mold, 48, 117, 224
 souring, 224
 southern blight, 62, 225
 sunscald, 28, 119, 219, 225
 thread blight, 225
 twig blight, 63, 118, 224
 web blight, leaf blight, 37, 225
 winter injury, 28, 117, 219, 225
 wood rot, 64, 142, 225
Flammarigold, 253
 root-knot, 75, 253
 sooty mold, 48, 253
Filbert, 142; *see also Hazelnut*
 bacterial blight, 33, 143
 canker, 63, 143
 crown gall, 68, 143
 leaf blister, 47, 142
 leaf spot, 33, 142
 powdery mildew, 41, 143
 twig blight, 63, 143
Filipendula, 356
Filmfast, 104
Finocchio, 175; *see also Fennel*
 bacterial soft rot, 68, 176
Fir, 330
 black mildew, 48, 333
 brown felt blight, 334
 canker, 63, 331
 mistletoe, 79, 333
 needle blight, cast, 37, 330
 root rot, 73, 117, 333
 rust, needle, 44, 45, 332
 witches'-broom, 45, 333
 seed treatment, 333
 seedling blight, 62, 333
 snow blight, 334
 sunscorch, wind injury, 28, 334
 tar spot, 33, 330
 tip blight, 37, 330
 twig blight, 63, 330, 331
 wood rot, 64, 142, 330
 Fire blight, [65], 66, 114, [115]
Fire-chalice; *see Zauschneria*
Fire-pink; *see Silene*
Firecracker plant; *see Cigar-flower*
Firethorn; *see Pyracantha, Apple*
Firewheel, 181; *see also Gailardia*
 aster yellows, 59, 183
 white smut, 50, 186
Firmiana, 329
Fishhook cactus; *see Cactus, Mammillaria*
Fittonia, 368
Fixed copper fungicides, 88
Flagella, [8], 9
Flame violets, 109
Flannel-bush; *see Fremontia*
Flash-flame pasteurizers, 439
Flax, flowering, 225
 aster yellows, 59
 curly-top, 60, 226
 damping-off, 62, 225
 gray-mold, 38
 root-knot, 75, 134, 226
 rust, 45
 stem rot, 62, 225
Fleabane, 181; *see also Erigeron*
 aster yellows, 59, 183
 downy mildew, 40, 185
 mosaic, 57, 184
 powdery mildew, 41, 183
 rust, 43, 45, 184
 spotted wilt, 58, 184
 verticillium wilt, 53, 184
 white smut, 50, 186
Floras-paintbrush; *see Emilia*
Florida yellowtrumpet, 399
 root rot, 73, 117, 399
 rust, 45, 399
Florist, 3
Flower
 blight, 70, [71]
 breaking, 55, [56]
 diseases, 70-73
 drop, 28
 fertilizing, 19
Flower-of-an-hour, 246; *see also Roselle*
 leaf spot, 33, 246
 root-knot, 75, 247
 root rot, 73, 247
Flowering almond, 315; *see also Almond*
 bacterial leaf spot, 33, 318
 blossom blight, 70, 315
 brown rot, 70, 315
 fire blight, 66, 70, 114, 324
 gray-mold blight, rot, 38, 323
 powdery mildew, 41, 322
 root rot, 73, 117, 323
 shot-hole, 37, 318, 322, 323
 thread blight, 324, 409
 twig blight, 63, 315, 322
Flowering apricot; *see Apricot*
Flowering cherry, 315; *see also Cherry*
 bacterial leaf spot, 33, 318
 blossom blight, 70, 315
 dieback, 63, 315, 322
 fire blight, 66, 70, 114, 324
 leaf blister, 47, 316
 leaf spot, shot-hole, 33, 37, 317, 318, 322, 323
 mottle complex, 57, 321
 plum decline (virus), 320
 powdery mildew, 41, 322
 root nematode, 323
 scab, 50, 318
 twig blight, 63, 315, 322
 wet feet, 324
 winter injury, 28, 323
 witches'-broom, 47, 316
Flowering currant, 201; *see also Currant*
 anthracnose, 37, 201
 bacterial leaf spot, 33
 dieback, 63, 202
 fruit rot, 70, 202
 gray-mold blight, dieback, 38, 202
 leaf spot, 33, 201
 rust, 45, 202
Flowering flax; *see Flax, flowering*
Flowering kale; *see Kale, Cabbage*
Flowering maple; *see Abutilon*
Flowering peach; *see Peach*
Flowering quince, 114; *see also Apple, Quince*
 black rot, 33, 63, 70, 116
 blossom blight, 66, 70, [115]
 canker, dieback, 63, 116, 118
 crown gall, 68, 117
 fire blight, 66, 70, 114, [115]
 fruit spot or rot, 70, 118
 leaf blight, 37, 120
 leaf spot, 33, 120
 root-knot, 75, 121
 root rot, 73, 117
 rust, 43, 45, 116
 twig blight, 63, 118
Flowering raspberry, 347; *see also Raspberry*
 cane blight, 63, 348
 leaf curl, 57, 348
 leaf spot, 33, 350
 mosaic, 57, 348
 powdery mildew, 41, 350
 rust, 41, 349, 350
Flowering tobacco, 389; *see also Tomato*
 aster yellows, 58, 394
 bacterial wilt, 55, 395
 crown gall, 68, 397
 curly-top, 60, 394
 downy mildew or blue mold, 40, 396
 early blight, 35, 389
 fasciation, 67, 314, 397
 leaf spot, 33, 390
 mosaic, 57, 392
 powdery mildew, 41, 397
 ringspot, 58, 394
 root-knot, 75, 395
 root nematode, 395
 root rot, 73, 396
 spotted wilt, 58, 393
Flazon Tree Wound Paint, 386
Fluxit, 104
Fly-honeysuckle; *see Honey-suckle*
Foamflower, 252
 powdery mildew, 41, 252
 rust, 45, 252

- Foeniculum, 175
 Fogfruit; *see* Lemon-verbena
 Foliage diseases, 33-62
 Foliar nematode, 60, [61]
 Foot rot, 62
Forestiera, 124
 mistletoe, 79, 125
 powdery mildew, 41, 125
 root rot, 73, 125
 rust, 45, 124
Forget-me-not, 288
 aster yellows, 59, 288
 black ringspot, 57, 288
 crown rot, wilt, 62, 208, 288
 downy mildew, 40, 288
 gray-mold blight, 38, 288
 powdery mildew, 41, 288
 rust, 45, 288
Formaldehyde, Formalin
 bulb or corm soak, 78, 206,
 235, 256, 280, 401, 429-
 30
 disinfectant, 68, 83, 342, 357,
 359, 382
 precautions, 439, 440
 treating soil, 299, 355, 439
Formula Z, 89
Forsythia, 226
 anthracnose, 37, 226
 bacterial blight, shoot blight,
 33, 55, 226, 276
 blossom blight, 70, 226
 cane blight, dieback, 63, 226
 crown gall, 68, 117, 226
 leaf spot, 33, 226
 pruning, 21
 root-knot, 75, 226
 root nematode, 226
 root rot, 73, 226
 southern blight, 62, 132, 226
 stem gall, 226
 twig blight, dieback, 63, 226
Fortunella, 187
Four-o'clock, 227
 curly-top, 60, 136, 227
 downy mildew, 40, 227
 leaf spot, 33, 227
 root-knot, 75, 134, 227
 root rot, 73, 227
 rust, 43, 45, 227
 white-rust, 47, 227
Foxglove, 368
 anthracnose, 37, 369
 crown gall, 68, 370
 curly-top, 60, 370
 flower blight, 70, 184, 370
 fusarium wilt, 53, 369
 leaf blight, 37, 369
 leaf spot, 33, 369
 leaf and stem nematode, 61,
 370
 mosaic, 57, 369
 ringspot, 58, 370
 root-knot, 75, 369
 root rot, 73, 369
 seed treatment, 369, 429, 433
 soil drench, 369
 stem rot, wilt, 62, 63, 369
 verticillium wilt, 53, 369
Fragaria, 375
Fragrant glad, 232; *see also*
Gladiolus
 dry rot (*Stromatinia*), 70, 232
Frangipani, 298
 mistletoe, 79, 298
 root rot, 73, 117, 298
 rust, 45, 298
Franklin-tree, 227
 black mildew, 48, 227
 leaf spot, 33, 227
 root rot, 73, 227
Franklinia, 227
Frasera, 230
Fraxinus, 124
Freesia, 232; *see also* Gladiolus
 bacterial scab, 33, 50, 234
 corm rot, 75, 232, [233]
 leaf spot, 33, 234
 mosaic, 57, 234
 root-knot, 75, 235
 yellows (*Fusarium*), wilt, 53,
 232
Fremontia, 329
 collar rot, stem girdle, 62,
 211, 329
 leaf spot, 33, 329
 verticillium wilt, 53, 329
French-mulberry; *see* Callicarpa
Frijolito; *see* Sophora
Fringetree, 124
 leaf spot, 33, 124
 powdery mildew, 41, 125
 root rot, 73, 125
 wood rot, 64, 124
Fritillaria, 399
Fritillary, 399; *see also* Tulip
 bulb rot, 75, 400
 leaf spot, 33, 402
 mosaic, 57, 401
 rust, 45, 402
Froelichia, 189
 damping-off, seed rot, 62, 189
 leaf spot, 33, 181, 189
 root-knot, 75, 189
 root rot, 73, 189
 white-rust, 47, 186, 189
Frost crack, 29
Frostweed; *see* Sunrose
Frostwort, 381
 leaf spot, 33, 381
Fruit
 diseases, 70-73
 fertilizing, small, 19
 spot, speck, rot, or blotch, 70,
 [72]
 spray amounts, needed, 426
 spray schedules, 423-25
Fuchsia, 228
 gray-mold blight, 37, 228
 leaf spot, 33, 181, 228
 powdery mildew, 41
 root-knot, 75, 110, 228
 root rot, 73, 228
 rust, 45, 228
 spotted wilt, 58, 140, 228
 verticillium wilt, 53, 228
Fulex A-D-O, 456
Fumazone, 73, 77, 89, 323, 324,
 441, 444
Fumigant, Fumigation, soil
 application of, 440-44
 fungi control, 439-40
 nematode control, 89, 440-44
 precautions in using, 89, 440-
 44
 trade names, 89, 440, 442-44
 uses, 83, 89, 442-44
 waiting period, 440-44
Fungicide, 85, 268
Fungi, 9, [10]
 diseases caused by, 10
 fruiting bodies, [64]
 penetration, [10]
 sclerotia, 10
 spores, 9, [10]
 germination, [10]
Fungicide
 acti-dione, 89
 active ingredients, 86-87, 419
 application equivalents, 418
 captan, 86, 419
 chemotherapeuticant, 84
 chloranil, 86, 419
 common names, 86-87, 419
 compatibility chart, 446
 copper, fixed, 88
 definition, 84
 dichlone, 86, 419
 disinfesting soil, 439-40, 442-
 43
 distributors and manufacturers, 86-87, 104, 106, 419
 eradicator, 84
 ferbam, 86, 419
 fruit spray schedules, 423-25
 gallon lots, 422
 karathane, 85
 lawn, 89, 266-71
 liquid, preparation of small
 amounts, 422
 maneb, 86, 419
 mercuric chloride, 85, 427
 modern, 84, 419
 multipurpose mixes, 91
 phaltan, 88
 precautions, 89-90, 423, 425,
 427
 preparation of spray mixtures,
 420-22
 protective, 84
 purchasing, 85
 schedule, 84, 423-25
 seed treatment, 427-36
 "shot-gun" soil drench, 92
 sulfur, 88, 91
 terraclor, 85
 thiram, 87, 419
 trade names, 86-87, 419
 uses, 86-87, 419
 zineb, 87, 419
 ziram, 87, 419
Fungus leaf spot, 33-35, [34]
Furcraea, 178
 leaf scorch, 35, 178
 root-knot, 75, 178
Fusarium wilt or yellows, 51,
 [52]

G

- Gaillardia, 181**
-
- aster yellows, 59, 183
-
- downy mildew, 40, 185
-
- leaf spot, 33, 181
-
- mosaic, 57, 184
-
- powdery mildew, 41, 183
-
- root nematode, 186
-
- root rot, 73, 183
-
- rust, 43, 45, 184

- spotted wilt, 58, 184
white smut, 50, 186
- Galanthus*, 204
- Galax*, 228
leaf spot, 33, 228
- Galinsoga*, as virus source, 58
- Gallium*, 154
- Gall*
bacterial root, 68
cane, 68, [69]
crown, 68, [69]
leaf, 47
leaf nematode, 60
- Galtonia*, 399
- Garden cress*, 155; *see also Peppergrass*
clubroot, 75, 156
curl-top, 60, 159
downy mildew, 40, 157
leaf blight, 37, 158
leaf and stem nematode, 61
mosaic, 57, 159
ringspot, 58, 159
rust, 43, 45, 160
seed treatment, 156, 429, 431
white-rust, 47, 158
- Garden Dowfume*, 422
- Garden-heliotrope*; *see Valerian*
- Garden hose sprayers*, 95, [98]
- Garden pinks*; *see Pinks, garden*
- Garden supply dealer*, 3
- Gardenia*, 228
bacterial leaf spot, 33, 229
bud drop, 229
chlorosis, 16, 230
crown gall, 68, 230
dieback, 63, 230
fungus leaf spot, 33, [229]
gray-mold blight, petal blight, 37, 70, 230
powdery mildew, 41, 230
root-knot, 75, 229
root nematode, 230
root rot, 73, 230
soil mixture for, 16
sooty mold, 48, 230
stem canker or gall, 63, 228, [229]
- Garland flower*; *see Daphne*
- Garlic*, 299; *see also Onion*
aster yellows, 59, 302
bacterial soft rot, 68, 75, 299
black mold, 48, 75, 301
blast, 35, 38, 300
bulb or clove rot, 53, 75, 299
canker, 63
clove treatment, 300, 428, 430, 432
downy mildew, 40, 300
gray-mold neck rot, 38, 75, 299
leaf blight, 37, 300, 302
mosaic, 57, 301
pink root, 73, 300
root-knot, 75, 301
rust, 45, 302
smut, 47, 299
southern blight, 62, 302
stem and bulb nematode, 61, 78, 300
verticillium wilt, 53, 302
white rot, 75, 299
- Garrya*, 211
- Gas injury, 30
- Gaultheria*, 243; *see also Checkberry, Salal*
black mildew, 48, 243
fruit spot, 70, 243
leaf spot, 33, 243
powdery mildew, 41, 243
red leaf gall, 243
sooty mold or blotch, 48, 243
spot anthracnose, 35, 243
- Gayfeather*; *see Liatris*
- Gauldasacia*, 145
- Gazania*, 181
crown rot, 62, 183
- Gelsemium*, 153
- General Chemical Division, Allied Chemical Corporation*, 86, 87, 104, 419
- General diseases*, 33–80
- Genista*, 151
- Gentian*, 230
botrytis blight, 37, 38, 230
damping-off, 62, 231
leaf spot, 33, 230
root rot, 73, 231
rust, 45, 230
stem canker, rot, 62, 63, 230, 231
- Gentiana*, 230
- Geranium* of florists, 231; *see also Cranesbill*
bacterial leaf spot and stem rot, 33, 55, 68, 231
blackleg, [62], 231
blossom blight, 70, [71], 231
crinkle, 231
crown gall, 68, 232
curl-top, 60, 231
cutting rot, 62, 231
gray-mold blight, *botrytis* blight, 37, 38, [39], 70, [71], 231
leaf curl, 59, 231
leaf nematode, 61, 232
leaf spot, 33, 231
leaf gall or fasciation, [67], 232
mosaic, 57, 231
mottle, 57, 231
oedema or dropsy, 28, 232
ringspot, 58, 231
root-knot, 75, 232
root nematode, 231
root rot, 73, 231
spotted wilt, 58, 231
stem rot, 62, 63, 231
verticillium wilt, 53, 232
- Gerbera*, 181
- German camomile*; *see Matricaria*
- German ivy*; *see Senecio*
- Germanender*, 362
downy mildew, 40, 363
leaf spot, 33, 362
powdery mildew, 41, 363
root-knot, 75, 362
rust, 45, 362
- Gerox*, 452
- Gesneria*, 109
- Geum*, 356
- Gherkin*; *see West Indian gherkin*
- Giant cactus; *see Cactus, Saguaro*
- Giant daisy; *see Chrysanthemum*
- Giant night white bloomer; *see Morning-glory*
- Giant sequoia; *see Sequoia*
- Gilbert's Tree Wound Dressing*, 386
- Gilia*, 327
aster yellows, 59, 328
downy mildew, 40, 328
leaf spot, 33, 327
mosaic, 57, 328
powdery mildew, 41, 327
root-knot, 75, 328
root rot, 73, 328
rust, 45, 328
soil drench, 328
- Gilsonite-varnish* wound dressing, 386
- Ginkgo*, 232
anthracnose, 37, 232
leaf spot, 33, 232, 286
root-knot, 75, 232, 323
root rot, 73, 232
wood rot, 64, 142, 232
- Girdling roots*, 30
- Gladiolus*, 232
aster yellows, grassy-top, 59, 235
bacterial leaf spot and blight, 33, 234
bacterial scab, 33, 50, 75, [234]
bulb nematode, 77, 235
chlorosis, 16–17, 235
collar rot, 50, 62, 232, 235
corm rot, 37, 68, 70, [74], 75, 232
corm treatment, 233, 235, 428, 434
cormel soak, 233, 429
flower spike dip, 234
flower spot and blight, 37, 70, [71], 232, 233, 234
leaf blight, 37, 38, 232
leaf spot, 33, 234
mosaic, flower breaking, 57, 234
neck rot, 62, 234, 235
ringspot, 58
root-knot, 75, 235
root nematode, 235
root rot, 73, [74], 235
smut, 47, 235
southern blight, 62, 232
topple, calcium deficiency, 18
white break, 57, 234
wilt or yellows (*Fusarium*), 53, 75, 232
- Gleditsia*, 248
- Globe-amaranth*, 189; *see also Amaranth*
curl-top, 60, 136, 189
gray-mold blight, 38, 185, 189
leaf spot, 33, 181, 189
root-knot, 75, 189
white-rust, 47, 186, 189
yellows, 59, 137, 189
- Globe artichoke*, 272
curly dwarf, 59, 273
gray-mold blight, 38, 273

- Globe artichoke (*continued*)
leaf spot, 33, 274
powdery mildew, 41, 274
root-knot, 75, 134, 275
southern blight, 62, 272
stem rot, 62, 272
yellows (virus), 59, 273
- Globe lily; *see* *Calochortus*
- Globe-tulip; *see* *Calochortus*
- Globeflower, 112
leaf spot, 33, 112
smut, 47, 113
- Globemallow, 246
powdery mildew, 41, 247
root rot, 73, 247
rust, 45, 246
- Globethistle, 181
crown and root rot, 62, 73, 183
- Glory-of-the-snow, 399; *see also* Tulip
bulb nematode, 78, 401
bulb soak, 429, 430, 435
- Glorybower; *see* *Clerodendron*
- Gloryvine; *see* Grape
- Glowing gold; *see* *Thermopsis*
- Gloxinia, 109
aster yellows, 59, 110
bud drop, 110
bud rot (*Botrytis*), 38, 109
crown, stem rot, 62, 109
flower blight, 70, 109, 110
leaf nematode, 61, 110
leaf rot, 37, 109
root nematode, 109
root rot, 73, 109
sclerotinia blight, 70, 110
spotted wilt, 58, 110
- Glycodin, 452
- Goatsbeard, 356
fire blight, 66, 114, 360
leaf spot, 33, 358
stem canker, 63, 357
- Godetia, 228
aster yellows, 59, 183, 228
curly-top, 60, 184, 228
damping-off, 62, 228
downy mildew, 40, 185, 228
root-knot, 75, 110, 228
root rot, 73, 228
rust, 45, 228
spotted wilt, 48, 140, 228
- Gold-dust; *see* *Alyssum*
- Gold-dust-tree, 126
- Golden-aster, 181
leaf spot, 33, 181
powdery mildew, 41, 183
rust, 45, 184
- Golden chinquapin, 179
blight, canker, 63, 179
leaf blister, 47, 179, 295
leaf spot, 33, 179, 284
oak wilt, 179, 295
powdery mildew, 41, 179
root rot, 73, 117, 179
wood rot, 64, 179
- Golden currant; *see* Flowering currant
- Golden marguerite; *see* Camomile
- Golden-pea; *see* *Thermopsis*
- Golden rose of China; *see* Rose
- Golden-shower; *see* *Cassia*
- Golden-wave; *see* *Coreopsis*
- Goldenbells; *see* *Forsythia*
- Goldenechain, 236
leaf spot, 33, 236
mosaic, infectious variegation, 57, 236
root-knot, 75, 236
root rot, 73, 236
twig blight, 63, 236
- Goldenegegs; *see* Evening-primrose
- Goldenglow (*Rudbeckia*), 181
aster yellows, 59, 183
downy mildew, 40, 185
leaf spot, 33, 181
mosaic, 57, 184
powdery mildew, 41, 183
root rot, 73, 183
rust, 45, 184
southern blight, 62, 183
stem or crown rot, 62, 183
white smut, 50, 186
yellow dwarf, 59, 184
- Goldenlarch, 264; *see also* Larch canker, 63, 264
- Goldenrain-tree, 236
coral spot, twig canker, 63, 236
leaf spot, 33, 236
verticillium wilt, 53, 236
- Goldendrod, rust, 43
- Goldentuft; *see* *Alyssum*
- Goldflower; *see* St.-Johns-wort
- Goldthread, 208
leaf spot, 33, 209
- Gomphrena, 189
- Goodrite P.E.P.S., 104
- Gooseberry, 201
anthracnose, 37, 201
bud nematode, 61, 203
cane blight, 63, 202
cutting dip, 203, 429, 436
dieback, 37, 63, 202
downy mildew, 40, 203
fruit rot, 60, 202
leaf spot, 33, 201
mosaic, 57, 203
powdery mildew, 41, 202
root rot, 73, 117, 203
rust, 43, 45, 202
scab or spot anthracnose, 50, 201
spray schedule, 424-25
sunscald, 28, 203
thread blight, 203, 409
- Gordonia, 227
- Gourds, 196; *see also* *Cucurbit*
angular leaf spot, 33, 197
anthracnose, 35, 196
bacterial soft rot, 68, 200
bacterial spot, 33, 201
bacterial wilt, 55, 197
blossom blight, 70, 201
damping-off, seed rot, 62, 200
downy mildew, 40, 199
fruit spot or rot, 68, 70, 200
leaf spot, 33, 197
mosaic, 55, 199
powdery mildew, 41, 199
root-knot, 75, 200
root rot, 73, 132, 200
seed treatment, 196, 431
- Grade changes, 30, [31], [32]
- Grafting, in transmitting viruses, 11
- Grammatophyllum, 302
- Granadilla; *see* Passionflower
- Grape, 237
anthracnose, leaf scab, 37, 239
black rot, 33, 237, [238]
boron deficiency, 17, 239
chlorosis, 16-18, 240, 285
crown gall, 68, 117, 239
dead arm, 63, 64, 238
dieback, canker, 63, 238
downy mildew, [40], 237
funleaf, infectious degeneration, 240
fly speck, 238
fruit rot, spot, 37, 70, 237, [238], 239
gray-mold blight, 37, 70, 238, 240
leaf blotch, 37, 240
leaf spot, 33, 237, 240
leafroll, white emperor disease, 240
mosaic, yellow, 57, 240
Pierce's disease, 59, 240
powdery mildew, 41, 238
root dip, 239, 429, 436
root-knot, 75, 237
root nematode, 240
root rot, 73, 117, 239
rust, 45, 240
shoot or cane blight, 63, 240
spot anthracnose, bird's eye rot, 37, 70, 239, 240
spray schedule, 424-25
2,4-D injury, 237, [238]
verticillium wilt, 53
wood rot, 64, 239
zinc deficiency, little leaf, 17, 239, 407
- Grape-hyacinth, 399; *see also* Hyacinth
bulb rot, 75, 400
bulb and stem nematode, 61, 78, 401
bulb treatment, 435
flower smut, 47, 402
- Grape ivy; *see* *Cissus*
- Grapefruit, 187; *see also* *Citrus*
anthracnose, 37, 187
bacterial blast, 33
chlorosis, 16, 187
crown gall, 68, 117, 187
fruit rot, 70
leaf spot, 33, 187
root nematode, 187
root rot, 73, 187
scab or spot anthracnose, 37, 50, 187
sooty blotch, 48, 187
twig blight, 63, 187
- Grass clippings, 16
- Grasshoppers, as virus carriers, 83, 394
- Gray-mold blight, 37-39, [38]
- Great laurel; *see* *Rhododendron*
- Greek valerian; *see* *Polemonium*
- Green manure, 16
- Green tip spray, 424
- Grevillea, 367
- Gromwell; *see* *Lithospermum*

- Ground-hemlock; *see* Yew
 Ground-ivy; *see also* Catnip
 leaf spot, 33, 362
 mosaic, 57, 363
 Ground-myrtle; *see* Vinca
 Ground-pink; *see* Phlox
 Groundcherry, 389
 angular leaf spot, 35, 391
 curly-top, 60, 394
 leaf spot, 33, 390
 leaf and stem nematode, 61, 328, 397
 mosaic, 57, 392
 ringspot, 58, 394
 root-knot, 75, 396
 root rot, 73, 396
 rust, 45, 397
 southern blight, 62, 396
 white smut, 50, 397
 wildfire, 35, 391
 Groundsel, 181; *see also* Senecio
 aster yellows, 59, 183
 damping-off, seed rot, 62, 183
 downy mildew, 39, 185
 fusarium wilt, 53, 184
 leaf nematode, 61, 185
 powdery mildew, 41, 183
 rust, 45, 184
 seed treatment, 183
 verticillium wilt, 53, 141, 184
 white-rust, 47, 186
 white smut, 50, 186
 Growing conditions, unfavorable, 7
 Guava, 292
 anthracnose, 37, 292
 fruit spot or rot, 70, 292
 leaf spot, 33, 292
 root-knot, 75, 292
 root nematode, 292
 root rot, 73, 117, 292
 spot anthracnose or scab, 50, 292
 thread blight, 293, 409
 wood rot, 64, 293
 Guernsey-lily, 204
 leaf scorch or red spot, 37, 205
 root nematode, 205, 207
 Guinea bean; *see* Cucurbit
 Guinea gold; *see* Marigold
 Guinea-hen flower; *see* Fritillary
 Gymnosporangium (bacterial), 66
Gymnocalidium, 248
Gypsophila, 169
Gypsum, 18, 324
- H**
- Hackberry, 241
 downy mildew, 41, 241
 felt fungus, canker, 63, 241
 leaf blight, 37, 241, 284
 leaf spot, 33, 241, 286
 mistletoe 79, 241
 mosaic, 57, 219, 241
 powdery mildew, 41, 241
 root rot, 73, 117, 241
 seedling blight, 62, 333
 thread blight, 241, 409
 winter injury, 28, 219, 241
 witches'-broom, 241, [242]
 wood rot, 64, 142, 241
- Hail injury, 30
 Hairy root, 68, 117
Halesia, 367
 leaf spot, 33, 284, 367
 wood rot, 64, 142, 367
Hamamelis, 412
 Hardhack, 374; *see also* Spirea
 leaf spot, 33, 374
 powdery midlew, 41, 374
 stem girdle, canker, 63
 Hardy amaryllis; *see* *Lycoris*, Amaryllis
 Hardy aster; *see* Aster, perennial
 Hardy grass pink; *see* Carnation
 Hardy orange, 187; *see also* Citrus
 anthracnose, 37, 187
 canker, dieback, 63, 187
 fruit rot, 70
 leaf yellowing, 187
 root nematode, 187
 root rot, 73, 187
 spot anthracnose or scab, 50, 187
 twig blight, 63, 187
Harebell, 140; *see also* Bellflower, *Campanula*
 rust, 45, 141
Hawksbeard, 181
 leaf spot, 33, 181
 powdery mildew, 41, 183
 rust, 45, 184
Haworthia, 111
Hawthorn, 114
 black rot, 33, 63, 116
 blossom blight, 70, 114
 felt fungus canker, 63, 122
 fire blight, 66, 70, 117
 fruit spot or rot, 70, 118
 gray-mold rot, 38, 114, 118
 leaf blight, 37, [120]
 leaf spot, 33, 120
 mistletoe, 79, 121
 powdery mildew, 41, 117
 root rot, 73, 117
 rust, 43, 45, [116]
 scab, 50, 115
 seedling blight, 62, 333
 sooty mold, 48, 117
 wood rot, 64, 119
- Hayes Spray Gun Company, 106
- Hazelnut*, 142
 bacterial spot, blight, bacteriosis, 35, 143
 canker, dieback, 63, 143
 crown gall, 68, 117, 143
 dieback, 63, 143
 kernel rot or stain, 70, 143
 leaf blister, 47, 142
 leaf spot, 33, 142
 powdery mildew, 41, 143
 root rot, 73, 143
 sooty mold, 48, 143
 twig blight, 63, 143
 wood rot, 64, 142
- HCB, 299
- Heal-all*; *see* *Prunella*
- Heart rot, 64
- Hearts and honey vine; *see* Morning-glory
- Heat treatments, soil, 437-39
- Heath, 243
 chlorosis, "yellows," 16, 243
 damping-off, cutting rot, 62, 243
 gray-mold blight, 38, 243
 powdery mildew, twist, 41, 243
 rust, 45, 243
 stem or collar rot, 62, 243
 verticillium wilt, 53, 243
- Heather, 243
 chlorosis, 16, 243
 collar rot, 62, 243
 root rot, 73, 243
- Heavenly bamboo; *see* *Nandina*
- Hebe, 373; *see also* Speedwell
 fusarium wilt, 53, 373
 leaf spot, 33, 373
- Hedera*; *see* Ivy
- Hedge, pruning, 21
- Hedgenettle; *see* *Stachys*
- Hedgethorn; *see* *Carissa*
- Helenium*, 181
- Helianthemum*, 381
- Helianthus*; *see* Jerusalem-artichoke, Sunflower
- Helichrysum*, 181
- Heliospermum*, 181
 black patch, 37, 181
 leaf spot, 33, 181
 mosaic, 57, 184
 powdery mildew, 41, 183
 root rot, 73, 183
 rust, 45, 184
- Heliotrope*, 288
 curly-top, 60, 288
 gray-mold blight, shoot blight, 38, 288
 leaf scorch, 28, 288
 leaf spot, blight, 33, 37, 181, 288
 mosaic, 57, 288
 root-knot, 75, 288
 rust, 43, 45, 288
 southern blight, 62, 288
 verticillium wilt, 53, 208, 288
- Heliotropium*, 288
- Helleborus*, 208
- Helixine*, 129
- Hemerocallis*, 244
- Hemlock*, 330
 canker, 63, 331
 damping-off, 62, 333
 gray-mold blight, 38, 333
 mistletoe, dwarf, 79, 333
 needle or leaf blight, 37, 330
 root rot, 73, 117, 333
 rust, needle and cone, 43, 45, 332
 seed treatment, 333
 seedling blight, 62, 333
 snow blight, 334
 soil drench, 333
 sunscorch, 28, 334
 twig blight, 63, 330, 331
 wood rot, 64, 142, 330
- Hen-and-chickens*, 366
 leaf and stem rot, 37, 366
 root rot, 73, 366
 rust, 45, 366
 soil drench, 366
- Hepatica*, 112; *see also* Liverleaf
 smut, 47, 113

- Herb Robert**, 194
Herbicide injury, 29, 30
Hercules-club (*Aralia*), 108
 canker, dieback, 63, 109
 leaf spot, 33, 108
 root rot, 73, 108
 spot anthracnose or scab, 33, 50, 108
 wood rot, 64, 109
Hercules-club (*Zanthoxylum*), 250; *see also* Prickly-ash
 canker, dieback, 63, 250
 leaf spot, 33, 250
 mistletoe, 79, 250
 rust, 45, 250
 wood rot, 64, 142, 250
Heronsbill, 194
 aster yellows, 59, 195
 bacterial leaf spot, 35, 195
 curly-top, 60, 195
 downy mildew, 41, 195
 root-knot, 75, 195
 root nematode, 195
 root rot, 73, 195
 southern blight, 62, 195
 stem or crown rot, 62, 195
Hesperis, 155
Heteroecious rust, 43
Heuchera, 252
 leaf nematode, 61, 253
 leaf spot, 33, 252
 powdery mildew, 41, 252
 root rot, 73, 231, 253
 rust, 45, 252
 smut, 47, 253
 stem rot, 62, 253
Hexachlorobenzene (HCB), 299
Hiba arborvitae, 259; *see also* Arborvitae
 twig blight, 63, 260
Hibiscus; *see* Hibiscus (arborecent forms), Okra, Rose-mallow
Hibiscus (arborecent forms), 246
 bacterial leaf spot, 33, 35, 246
 bacterial wilt, 55, 247, 395
 blossom blight, 70, 246, 247
 crown gall, 68, 247
 damping-off, 62, 247
 dieback, 63, 246
 gray-mold blight, 37, 246
 leaf blight, 37, 246
 leaf spot, 33, 246
 mosaic, 57, 247
 root-knot, 75, 247
 root nematode, 247
 root rot, 73, 247
 rust, 45, 246
 seed treatment, 247, 434
 stem or crown rot, 62, 247
 strapleaf, molybdenum deficiency, 160, 247
Hickory, 406; *see also* Pecan
 anthracnose, 37, 406
 bunch disease, 406
 canker, dieback, 63, 407
 crown gall, 68, 407
 felt fungus, 241, 409
 leaf blotch, 37, 406
 leaf scorch, 28, 284, 409
 leaf spot, 33, 406
 mistletoe, 79, 409
 nut mold, 70, 408
 powdery mildew, 41, 408
 root-knot, 75, 409
 root rot, 73, 117, 408
 rosette, zinc deficiency, 17, 407
 scab, 50, 70, 406, 408
 thread blight, 409
 witches'-broom, 406
 wood rot, 64, 142, 408
Highbush cranberry, 404; *see also* European cranberry-bush, Viburnum
 canker, dieback, 63, 404, 405
 powdery mildew, 41, 404
Hinoki cypress; *see* Chamaecyparis
Holly, 245
 black mildew, 48, 245
 canker, dieback, 63, 245
 chlorosis, 16, 245, 285
 felt fungus, 241, 245
 leaf blight, 37, 245
 leaf rot, drop of cuttings, 37, 245
 leaf scorch, 28, 245
 leaf spot, 33, 245
 powdery mildew, 41, 245
 root-knot, 75, 245
 root nematode, 245
 root rot, 73, 117, 245
 rust, 45, 245
 soil drench, 245
 sooty mold, 48, 245
 spine spot, 245
 spot anthracnose, 37, 245
 tar spot, 33, 245
 thread blight, 241, 409
 twig blight, 63, 245
 wood rot, 64, 142, 245
Hollygrape, 129
Hollyhock, 246
 anthracnose, 37, 246
 bacterial wilt, 55, 247, 395
 canker, 63, 246, 247
 fasciation, 67
 hairy root, crown gall, 68, 247
 leaf spot, 33, 246
 mosaic, 57, 247
 powdery mildew, 41, 247
 root-knot, 75, 247
 root nematode, 247
 root rot, 73, 247
 rust, 43, 45, [246]
 seed treatment, 434
 seedling blight, 62, 246
 southern blight, 62, 247
 stem or crown rot, 62, 247
 web blight, 134, 247
Holodiscus, 247
 canker, dieback, 63, 248
 fire blight, 66, 114, 248
 leaf blight, 35, 247
 leaf spot, 33, 247
 powdery mildew, 41, 247
 witches'-broom, 248
Homalomena, 162
 leaf spot, 33, 163
Home
 fruit disease control, 423-26
 nematode control, 440
Honesty, 155; *see also* Cabbage
 clubroot, 75, 156
 leaf spot, 33, 158
 mosaic, 57, 159
 ringspot, 57, 159
Honeydew
 growing in flowering sap, 48
 secretions by insects, 48
Honeydew melon, 196; *see also* Cucurbit
 bacterial leaf spot, 35, 197
 curly-top, 60, 199
 fruit spot, rot, 70, 200
 mosaic, 57, 199
 scab, 50, 197
 seed treatment, 196
 stem blight, 63, 200
Honeylocust, 248
 canker, dieback, 63, 248
 chlorosis, 16, 17, 249, 285, 407
 crown rot, 62, 211, 248
 felt fungus, 241, 249
 hairy root, 68, 117, 249
 leaf spot, 33, 249, 284, 286
 mistletoe, 79, 249
 powdery mildew, 41, 248
 root-knot, 75, 249, 323
 rust, 45, 249
 tar spot, 33, 249, 286
 verticillium wilt, 53, 249, 284
 winter injury, 28, 119, 249
 witches'-broom, 79, 249
 wood rot, 64, 142, 248
Honeysuckle, 371
 canker, dieback, 63, 371
 crown gall, hairy root, 68, 372
 gray-mold blight, 38, 372
 infectious variegation, 57, 372
 leaf blight, 37, 371
 leaf spot, 33, 371
 powdery mildew, 41, 372
 pruning, 21
 root-knot, 75, 323, 372
 root rot, 73, 372
 rust, 45, 371
 wood or collar rot, 64, 211, 372
 thread blight, 372, 409
 twig blight, 63, 371
Hophornbeam, 142
 canker, 63, 143
 leaf blister, 47, 142
 leaf spot, 33, 142
 powdery mildew, 41, 143
 root rot, 73, 143
 rust, 45, 142
 wood rot, 64, 142
Hopperburn, 186, 325, 343
Hoptree, 250
 leaf spot, 33, 250
 powdery mildew, 41, 250, 251
 root rot, 73, 250
 rust, 45, 250
Horehound, 362
 leaf spot, 33, 362
 root-knot, 75, 362
Hornbeam, 142
 canker, 63, 143
 felt fungus, 143
 leaf blister, 47, 142
 leaf spot, 33, 142
 powdery mildew, 41, 143
 root rot, 73, 143
 twig blight, 63, 143
 wood rot, 64, 142

- Horsechestnut, 250
 anthracnose, leaf blight, 37, 251
 bleeding canker, 63, 135, 251, 285
 canker, dieback, 63, 251
 leaf blister, yellow, 47, 142, 251
 leaf blotch, 37, [250]
 leaf scorch, 28, 251
 leaf spot, 33, 251
 mistletoe, 79, 251
 powdery mildew, 41, 251
 root rot, 73, 117, 251
 rust, 45, 251
 twig blight, 63, 218, 251, 285
 verticillium wilt, 53, 251, 284
 wetwood or slime flux, 218, 251
 witches'-broom, 47, 251
 wood rot, 64, 142, 251
- Horsemint; *see* Monarda
- Horseradish; *see also* Cabbage
 bacterial blight, 35, 156
 bacterial leaf spot, 35, 158
 bacterial soft rot, 68, 157
 brittle root, 60, 159
 clubroot, 75, 156
 crown gall, 68, 125, 160
 curly-top, 60, 159
 downy mildew, 41, 157
 leaf blight, 37, 157
 leaf spot, 33, 157
 mosaic, 57, 159
 powdery mildew, 41, 160
 root-knot, 75, 134, 158
 root rot, 73, 160
 root soak, 157, 158, 428, 431
 verticillium wilt, 53, 160
 white-rust, [46], 47, 158
- Hortensia; *see* Hydrangea
- Horticulturist, extension, 3, 4, 16, 19, 20, 22, 29, 80, 84
- Hosta, 251
 anthracnose, 37, 241
 crown rot, 62, 251
 leaf spot, 33, 251
 root rot, 73, 251
- Hot water soak, for seed, bulbs, tubers, potted plants, rhizomes, roots, 428-30
- Houndstongue, 288
 downy mildew, 41, 288
 leaf spot, 33, 181, 288
 mosaic, 57, 288
 powdery mildew, 41, 288
 root-knot, 75, 288
 root rot, 73, 231, 288
 southern blight, 62, 208, 288
 stem rot, 62, 208, 288
- House plants
 fertilizing, 19-20
 injury by, 20
 light, 27-28
 soil mixture, 16
 temperature, 28
 watering, 27-28
- Household bleach, as disinfectant, 22, 24, 66, 83
- Household sprayer, [93]
- Houseleek, 366
 leaf and stem rot, 37, 366
 root rot, 73, 366
- rust, 45, 366
 soil drench, 366
- Houstonia, 154
 downy mildew, 41, 154
 leaf spot, 33, 154
 root rot, 73, 117, 154
 rust, 45, 141, 154
- Huckleberry, 145
 black mildew, 48, 147
 fruit or berry rot, 70, 147
 leaf blight, spot, 33, 37, 147
 leaf gall, 47, 146
 powdery mildew, 41, 146
 red leaf gall, spot, 47, 146
 root-knot, 75, 148
 rust, 44, 45, 146
 spray schedule, 424-25
 tar spot, 33, 147
- H. D. Hudson Manufacturing Company, 106
- Humidity, air, 28
- Hunger Signs in Crops*, 17
- Husk-tomato; *see* Groundcherry
- Hyacinth, 399
 bacterial soft rot, 68, 400
 botrytis blight, 38, 70, 399
 bulb rot, 68, 75, 400
 bulb soak, 429, 430, 435
 mosaic, 57, 401
 ring disease or bulb nematode, 61, 77, [78], 401
 root rot, 73, 400
 rust, 45, 402
 "topple" or loose bud, 402
 yellows or yellow rot, 35, 75, 401
- Hyacinth-bean, 311; *see also* Pea
 bacterial spot, 35, 312
 black mildew, 48, 315
 leaf spot, 33, 314
 mosaic, 57, 312
 powdery mildew, 41, 312
 root-knot, 75, 314
 root rot, 73, 312
- Hyacinthus, 399
- Hydrangea, 252
 bacterial wilt, 55, 252
 bud blight, 252
 canker, dieback, 63, 253
 chlorosis, 16, 252
 damping-off, cutting rot, 62, 253
 flower blight, 70, 252
 gray-mold blight, 38, 70, 252
 leaf nematode, 61, 253
 leaf spot, 33, 252
 powdery mildew, 41, 252
 pruning, 21
 ringspot, 58, 253
 root-knot, 75, 252
 root rot, 73, 231, 253
 rust, 43, 45, 252
 southern blight, 62, 253
 stem, crown rot, 62, 253
 stem nematode, 253
 sunscald, 28, 119, 219, 253
 wood rot, 64, 142, 253
- Hydrocarbons, oxidized, injury, 29
- Hymenocallis, 204
- Hypericum, 362
- Hyssop, 362
- root-knot, 75, 362
Hyssopus, 362
- Iberis, 155
- Ice injury, 30
- Iceplant, 253
 root-knot, 75, 253
 sooty mold, 48, 253
- Flex; *see* Holly
- Illicium, 283
- Impatiens, 129
- Imperial Chemical Company, 106
- Incense-cedar, 259
 brown felt blight, 261, 334
 canker, 63, 260
 crown gall, 68, 117, 260
 mistletoe, 79, 261
 needle cast, 37, 260
 root rot, 73, 117, 260
 rust, gall, 45, 259
 witches'-broom, 45, 259
- wood rot, 64, 142, 260
- India rubber tree, 224; *see also* Rubber plant
 anthracnose, 37, 224
 canker, dieback, 63, 118, 224
 crown gall, 68, 140, 224
- Indian cherry; *see* Buckthorn
- Indian corn; *see* Corn
- Indian-cup; *see* Slipper
- Indian currant; *see* Coralberry
- Indian paintbrush; *see* Painted-cup
- Indian shot, 167
- Indian-tobacco; *see* Lobelia
- Indigo, 222
 powdery mildew, 41, 222
 root rot, 73, 222
 rust, 43, 222
- Indigobush, 222
 canker, 63, 222, 285
 leaf spot, 33, 222
 powdery mildew, 41, 222
 root rot, 73, 222
 rust, 45, 222
- Indigofera, 222
- Infectious variegation, 55
- Inflorescence blight, 70, [71]
- Inkberry, 245; *see also* Holly
 black mildew, 48, 245
 canker, dieback, 63, 245
 felt fungus canker, 241, 245
 sooty mold, 48, 245
 twig blight, 63, 245
- Insecticides, compatibility chart, 446
 protective schedule, 84
- Insects
 carriers of bacteria, 66, 232
 carriers of viruses, 11, 57, 58, 60, 83
 control, 33, 50, 53, 55, 57, 58, 60, 68, 70, 73
- Inula, 181
 leaf spot, 33, 181
 powdery mildew, 41, 183
 rust, 45, 184
- Ipomoea; *see* Morning-glory, Sweetpotato
- Iresine, 189

Iris, 254
 bacterial leaf spot or blight, 35, 256
 bacterial scab, 50, 234
 bacterial soft rot, [67], 68, 75, 254
 blindness, blasting, 257
 blossom blight, 70, 256
 bulb nematode, 78, [256]
 bulb rot, [62], 75, 254, [255]
 chlorosis, 16, 257, 358
 crown rot, [62], 254, [255]
 flower spot, 70, 256
 gray-mold blight, 38
 ink disease, [255], 257
 leaf blight, blotch, 37, 254, 257
 leaf spot, 33, [34], 254
 mosaic, stripe, 57, [255]
 rhizome or bulb soak, 254, 256, 428, 429, 430, 434
 rhizome rot, 38, [62], 75, 254
 ringspot, 58
 root-knot, 75, 257
 root nematode, 256
 root rot, 73, 254
 rust, 45, [256]
 scorch, red fire, 255
 soil drench, 254
 southern blight, 62, 254
 Iron chelates, 17, 270, 278, 285, 352, 359
 chlorosis, 17
 citrate, 285
 deficiency, 17
 phosphate, 285
 sulfate, 16, 278, 352, 359, 379, 396
 tartrate, 285
 Ironweed; *see* Yellow ironweed
 Ironwood; *see* Hophornbeam
 Ivy (Baltic, Canary, English), 257; *see also* Boston ivy, Cissus for Grape and Marine-ivy, Senecio for German-ivy, Toadflax for Kenilworth ivy
 anthracnose, 36, 257
 bacterial leaf spot, 33, [257]
 leaf spot, mold, 33, [257]
 powdery mildew, 41, 258
 root nematode, 258
 root rot, 73, 258
 sooty mold, 48, 258
 spot anthracnose or scab, 50, 257
 stem canker, 63, 257
 stem spot, dieback, 63, 257
 winter injury, sunscald, 28, 257
 Ivy-aryum; *see* Pothos
 Ixia, 232
 corm rot, 75, 232
 gray-mold blight, 38, 234, 323
 mosaic, 57, 234
 yellows (*Fusarium*), 51, 75, 232
 Ixora, 154
 root-knot, 75, 154
 root nematode, 154
 root rot, 73, 117, 154

J

Jacaranda, 174
 root rot, 73, 117, 175
 Jack-in-the-pulpit, 162
 leaf spot, mold, 33, 163
 leaf and stalk blight, 37, 38, 163
 rust, 45, 164
 Jackbean, 131; *see also* Bean
 leaf spot, 33, 134
 pod spot, 70, 133
 root-knot, 75, 134
 Jacobs-ladder; *see* Polemonium
 Jacquemontia, 290
 leaf spot, 33, 290
 root-knot, 75, 291
 root nematode, 291
 rust, 45, 290
 thread blight, 291, 409
 white-rust, 47, 158, 290
 Jade plant; *see* Crassula
 Japanese aucuba, 126
 Japanese cornelian cherry; *see* Dogwood
 Japanese lawnglass; *see* Zoysia
 Japanese pagodatree; *see* Sophora
 Japanese plum-yew, 258
 twig or nursery blight, 37, 63, 258, 260
 Japanese quince; *see* Flowering quince
 Japanese spurge; *see* Pachysandra
 Japanese zelkova; *see* Elm
 Jasmine, 258
 blossom blight, 70, 258
 crown gall, 68, 258
 crown rot, 62, 258
 leaf spot, 33, 258
 root-knot, 75, 258, 323
 root nematode, 258
 root rot, 73, 117, 258
 rust, 43, 258
 southern blight, 62, 258
 spot anthracnose or scab, 50, 258
 stem gall, 63, 258
 variegation, infectious chlorosis, 247, 258
 Jasminum, 258
 Jersey-tea; *see* New Jersey-tea
 Jerusalem-artichoke, 272
 bacterial spot, 35, 274
 crown gall, 68, 275
 downy mildew, 40, 41, 273
 leaf spot, 33, 274
 powdery mildew, 41, 274
 root and tuber rot, 62, 73, 272, 274
 rust, 43, 45, 274
 southern blight, 62, 272
 stem rot, 62, 272
 Jerusalem-cherry, 389; *see also* Eggplant
 bacterial soft rot, 68, 391
 crown gall, 68, 397
 early blight, 35, 389
 gray leaf spot, 33, 390
 late blight, 35, 389
 mosaic, 57, 392

spotted wilt, 58, 393
 verticillium wilt, 53, 395
 Jerusalem-cross; *see* Maltese cross, Carnation
 Jerusalem-thorn; *see* Parkinsonia
 Jessamine; *see* Carolina jessamine
 Jetbead, 259
 anthracnose, 37, 259
 fire blight, 66, 114, 259
 leaf spot, 33, 259
 twig blight, coral spot, 63, 259
 Jewelberry; *see* Callicarpa
 Joe-pe-weed, 181; *see also* Eupatorium
 downy mildew, 41, 185
 powdery mildew, 41, 183
 rust, 45, 184
 Jonquil; *see* Daffodil
 Josephs-coat; *see* Amaranth
 Joshua-tree; *see* Yucca
 Judas-tree; *see* Redbud
 Juglans, 406
 Juneberry; *see* Serviceberry, Amelanchier
 Junglefame; *see* Ixora
 Juniper, Redcedar, 259
 black mildew, 48, 49, 260
 brown felt blight, 261, 334
 canker, 63, 64, 260
 chlorosis, 16, 285
 crown gall, 68, 117, 260
 damping-off, 62, 260, 333
 leaf browning and shedding, 260
 mistletoe, 79, 261
 needle or leaf blight, cast, 37, 260
 nursery or juniper blight, 37, 63, 64, 260
 pruning, 22
 root nematode, 261
 root rot, 73, 117, 260
 rust, 43, 260
 gall, [44], 45, 260
 needle, 45, 260
 witches'-broom, 45, 260
 snow blight, 261, 334
 sooty mold, 48, 260
 twig blight, 63, 64, 260
 winter injury, 28, 260
 wood rot, 64, 142, 260
 Juniperus, 259
 Jupiters-beard; *see* Red-valerian

K

Kalanchoë, 366
 crown gall, 68, 366
 powdery mildew, 41, 366
 soil drench, 366
 stem or crown rot, wilt, 62, 63, 366
 Kale, 154; *see also* Flowering kale, Cabbage
 bacterial leaf spot, 35, 158
 bacterial soft rot, 68, 157
 black ringspot, 58, 159
 black rot, 35, 156

- blackleg, 63, 155
 clubroot, 75, 156
 damping-off, 62, 155, 156, 157
 downy mildew, 41, 157
 drop, cottony rot, 62, 70, 158
 fusarium yellows, 53, 155
 gray-mold blight, 38, 158
 leaf spot, 33, 157
 mosaic, 57, 159
 oedema, 28, 160
 powdery mildew, 41, 160
 root-knot, 75, 134, 158
 root rot, 73, 160
 seed treatment, 156, 428, 431
 southern blight, 62, 158
 verticillium wilt, 53, 160
 white-rust, 47, 158
- Kalmia, 145; *see* Mountain-laurel
Kalmiopsis, 145; *see* Mountain-laurel
Kalopanax, 108; *see* *Acanthopanax*
Kangaroo vine; *see* *Cissus*
Karathane, 85
 formulations (-WD, L), 85
 gallon lots, 422
 injury, 30
 in multipurpose mixes, 91
 powdery mildew, control, 85
Karbam Black, 86, 419
Karbam White, 87, 419
Kenilworth ivy; *see* *Toadflax*
Kentucky coffee-tree, 248
 leaf spot, 33, 249, 286
 root rot, 73, 117, 248
 sooty mold, 48, 249
 verticillium wilt, 53, 249, 284
 wood rot, 64, 142, 248
- Kerria, 261; *see* Jetbead for
 White kerria
 canker, 63, 261
 fire blight, 66, 114, 261
 leaf blight, 37, 261
 leaf spot, 33, 261
 root rot, 73, 261
 twig blight, 63, 261
- Knapsack duster, 100, [103], 104
 sprayer, [95]
- Kniphofia*, 351
- Kochia*, 136
 curly-top, 60, 136
 damping-off, 62, 136
 root rot, 73, 136, 138
 rust, 45, 138
 virus yellows, 59, 137
- Koelreuteria*, 236
- Kohlrabi*, 154; *see also* Cabbage
 bacterial soft rot, 68, 73, 157
 black ringspot, 58, 159
 black rot, 35, 156
 clubroot, 75, 156
 damping-off, 62, 155, 156, 157
 downy mildew, 41, 157
 drop, cottony rot, 73, 158
 fusarium yellows, 53, 155
 gray-mold blight, 38, 158
 leaf spot, 33, 157
 mosaic, 57, 159
 powdery mildew, 41, 160
 root-knot, 75, 134, 158
- root rot, 73, 160
 seed treatment, 156, 428, 431
 southern blight, 62, 158
 verticillium wilt, 53, 160
- Kolkher Methyl Bromide*, 443
- Kolkwitzia*, 404
- Krenite*
 control rust, 125
 injury, 30
 tree wound dressing, 66, 315
- Kromad*, 89, 266, 267, 269, 270
- Kumquat*, 187; *see also* *Citrus*
 fruit rot, 70
 leaf spot, 33, 187
 root nematode, 187
- L**
- Labrador-tea*, 261
 leaf gall, 47, 261
 leaf spot, 33, [262]
 powdery mildew, 41, 262
 rust, 43, 45, 262
 spot anthracnose, 35, 262
 tar spot, 33, 262
- Laburnum*, 236
- Lace-fern*; *see* *Asparagus-fern*
Laceflower; *see* *Blue laceflower*
Lachenalia, 399
Ladys-sorrel; *see* *Oxalis*
Laelia, 302
Lagenaria, 196
Lagerstroemia, 195
Lambkill; *see* Mountain-laurel
Lambs-ears; *see* *Stachys*
Lambslettuce; *see* *Cornsalad*
Lambsquarters, white-rust, 47
- Land-grant institutions, listing of, 4-5
 help by, 3
- Lantana*, 263
 black mildew, 48, 263
 fusarium wilt, 53, 263
 leaf nematode, 61, 263
 leaf spot, 33, 263
 mosaic, 55, 263
 root-knot, 75, 263
 root rot, 73, 264
 rust, 45, 263
- Larch*, 264
 canker, 63, 264
 damping-off, 62, 264
 frost injury, 28, 264
 leaf or needle cast, 37, 264
 mistletoe, dwarf, 79, 264
 needle blight, 37, 264
 root rot, 73, 117, 264
 rust, 43, 45, 264
 seed treatment, 264
 seedling blight, 37, 264
 shoot or twig blight, 63, 264
 wood rot, 64, 142, 264
- Larix*, 264
- Larkspur*, 208; *see also* *Delphinium*
 bacterial leaf spot, 33, 209
 curly-top, 60, 210
 leaf blotch, 37, 209
 mosaic, 57, 209
 seed treatment, 208
 soil drench, 208, 209
- Lavacide** 100, 442
- Lathyrus*, 311
- Latuca*, 272
- Laurel*; *see also* Mountain-laurel for Bog, Mountain-Pale, and Sheep-light requirements of, 27
- Lavandula*, 362
- Lavatera*, 246
 anthracnose, 37, 246
 damping-off, 62, 247
 infectious variegation, 57, 247
 leaf spot, 33, 246
 root rot, 73, 247
 rust, 45, 246
 seed treatment, 247, 434
- Lavender*, 362
 leaf spot, 33, 362
 root-knot, 75, 362
 root rot, 73, 231, 363
- Lavender queen*; *see* *Penstemon*
- Lawn*
 fertilizing, 18
 fungicides, broad-spectrum, 89
 trade names and distributors, 89
 watering, 27
- Laws, governing pesticides, 90
- Lawson cedar*; *see* *Chamaecyparis*
- Layia*, 181
- Leadplant*; *see* *Indigobush*
- Leadtree*, 248
 root rot, 73, 117, 248
 rust, 45, 249
- Leaf**
 blight, 35, [36], 37
 blister, 47
 blotch, 35, [36], 37
 curl, 47, [48]
 curl (virus), 55
 diseases, 33-62
 gall, 10, 47
 gall nematode, 60
 mold, 16
 nematode, 12, 60, [61]
 rust, 43, [44]
 smut, 47, [50]
 spot, 10
 bacterial, 33, [35]
 fungus, 33, [34], 35
- Leaf beet*, 136
- Leafhoppers*, 11
 control of, 60, 83
 as virus carriers, 11, 58, 60, 83
- Leafy gall*, 66, [67]
- Leatherleaf*; *see* *Chamaedaphne*
- Leatherwood*, 272; *see also* Southern leatherwood
 rust, 45, 272
 sooty mold, 48, 272
- Lebbek*; *see* "Mimosa" tree
- Ledum*, 261
- Leek*, 299; *see also* Onion
 aster yellows, 59, 302
 bacterial soft rot, 68, 75, 299
 bulb rot, 53, 68, 75, 299
 downy mildew, 41, 300

Leek (continued)

gray-mold neck rot, 38, 75, 299
 leaf blight, 37, 300, 302
 mosaic, 57, 301
 pink root, 73, 300
 purple blotch, 37, 300
 root-knot, 75, 301
 rust, 45, 302
 seed treatment, 432
 smudge, 75, 301
 smut, 47, 299
 southern blight, 62, 302
 tip blight, 300
 verticillium wilt, 53, 302
 white rot, 75, 299

Leiophyllum, 261

Lemaireocereus, 161

Lemon, 187; *see also Citrus*
 anthracnose, wither tip, 37, 187

chlorosis, 16, 187
 crown gall, 68, 117, 187

fruit spot or rot, 73

leaf spot, 33, 187

root nematode, 187

root rot, 73, 187

scab, 50

sooty blotch, 48, 187

twig blight, 63, 187

Lemon mint; *see Monarda*

Lemon-verbena, 263

black mildew, 48, 263

crown gall, 68, 264

leaf spot, 33, 263

root-knot, 75, 263

root rot, 73, 264

southern blight, 62, 231, 263

spot anthracnose, 37, 263

Lens, 311

Lentil, 311; *see also Pea*

gray-mold blight, pod rot, 38, 70, 314

mosaic, 57, 312

root-knot, cyst nematode, 75, 314

seed treatment, 312

wilt (virus), 312

Leonotis, 362

leaf spot, 33, 362

rust, 45, 362

Leopardsbane, 181

leaf nematode, 61, 185

powdery mildew, 41, 183

root-knot, 75, 134, 185

Lepidium, 155

Lettuce, 272

anthracnose, 37, 274

aster yellows or white heart, 59, 273

bacterial leaf blight, rot, 35, 274

bacterial soft rot, 68, 73, 272

bacterial wilt, 55, 274

big vein, 274

bottom rot, 62, 73, 272

brown blight, 275

crown gall, 68, 275

curly-top, 60, 275

damping-off, 62, 274

downy mildew, [40], 41, 273

drop, 62, 73, 272

fertilizing, 19

fusarium wilt or yellows, 51, 273

gray-mold blight, 38, 73, 273
 leaf spot, 33, 274
 marginal blight, 35, 274
 mosaic, 57, 273
 powdery mildew, 41, 274
 premature flowering, 28
 root-knot, 75, 134, 275
 root nematode, 275
 root rot, stunt, 73, 274
 rust, 45, 274
 seed rot, 274
 seed treatment, 274, 431
 seedbed treatment, 274
 slime mold, 267, 275
 southern blight, 62, 272
 spotted wilt, 58, 275
 temperature, effect on, 28
 tipburn, 273
 verticillium wilt, 53, 275
 white-rust, 47, 275

Leucaena, 248

Leucocum, 204

Leucophyllum, 388

Leucothoë, 261

black mildew, 48, 262
 black spot, 33, 262
 felt fungus, 241, 262
 leaf gall, 47, 261
 leaf spot, 33, [262]
 spot anthracnose, 35, 262
 tar spot, 33, 262

Liatris, 181

leaf spot, 33, 181
 powdery mildew, 41, 183
 root-knot, 75, 134, 185
 root rot, 73, 183
 rust, 45, 184
 stem rot, 62, 183
 verticillium wilt, 53, 141, 184

Libocedrus, 259

Light, 27-28

Lightning, injury, 32
 tree protection equipment, 32

Ligustrum, 345

Lilac, 275

anthracnose, 37, 276
 bacterial blight, 35, 55, 66
 blossom blight, 70, 276
 canker, 63, 276
 crown gall, 68, 277
 dieback, 63, 276
 frost injury, 28, 277
 graft blight, [277]
 gray-mold blight, flower
 blight, 38, 70, 276
 leaf blight or blotch, 37, 276
 leaf spot, 33, 276

light requirements of, 27

mosaic, 57, 276

powdery mildew, 41, [42], 275

pruning, 21

ringspot, 58, 276

root-knot, 75, 277, 323

root nematode, 276

root rot, 73, 276

shoot blight, 63, 66, 276

verticillium wilt, 53, 276

witches'-broom, 276

wood rot, 64, 142, 276

Lilium, 277

Lily, 277

bacterial soft rot, 68, 75, 278

botrytis blight, 37, 38, [39], 70, 277

brown scale rot, 75, [76], 278
 bulb rot, 68, 75, [76], 277, 278

bulb treatment, 278, 280, 429, 430, 434

chlorosis (noninfectious), 16, 278

damping-off, 62, 136, 280

fleck, 57, 278

flower breaking, 57, 278

frost injury, 28, 280

leaf and bud nematode, bumpy top, 61, 279

leaf scorch, burn, 278

leaf spot, 33, 280

mosaic, mottle, 57, 278, [279]

ringspot, 58, 278

root-knot, 75, 278

root nematode, 280

root rot, 73, 278, 279

rosette, yellow flat, 59, 278

rust, 45, 279

scale tip rot, 75, [76], 278

soft mealy rot, 75, [76], 278

southern blight, 62, 279

stem canker, 63, 279

stem or foot rot, stump rot, 62, 277, 279

Lily leek; *see Onion*

Lily-of-the-valley, 277

anthracnose, 37, 280

gray-mold blight, 38, 277

leaf blotch, 37, 280

leaf spot, 33, 280

rhizome or crown rot, 62, 75, 277, 279

root-knot, 75, 280

root nematode, 280

southern blight, 62, 279

Lima bean, 131; *see also Bean, garden types*

bacterial spot, 33, 131

chlorosis, 16, 135

curly-top, 60, 133

damping-off, 62, 133

downy mildew, 40, 133

mosaic, 55, 131

pod blight or spot, 70, 133, 134

root-knot, 75, 134

root nematode, 135

scab, 50, 134

seed rot, 133

seed treatment, 132, 133

stem anthracnose, 35, 134

Limb blight, 63

Lime, 187; *see also Citrus*

bacterial blast, 33

anthracnose, withertip, 37, 187

chlorosis, 16, 187

fruit rot, 73

root nematode, 187

root rot, 73, 187

scab, 50

twig blight, 63, 187

Lime-sulfur

injury, 88

uses, 88

Limestone, dolomite, 17, 18

ground, 18

Liming soil, 16

Limonium, 365

Linaria, 368

Lindane, 50, 57, 83

- Linden, 280
 anthracnose, 37, 280
 bleeding canker, 63, 135, 285
 canker, dieback, 63, 218, 280, 285
 damping-off, 62, 281, 333
 leaf blight, blotch, 37, 280
 leaf scorch, 28, 280
 leaf spot, 33, 281
 mistletoe, 79, 281
 powdery mildew, 41, 280
 root rot, 73, 117, 281
 seed rot, 281, 333
 sooty mold, 48, [49], 281
 spot anthracnose, 37, 281
 sunscald, 28, 119, 219, 281
 verticillium wilt, 53, 218, 284
 wetwood or slime flux, 218, 281
 winter injury, 28, 119, 219, 281
 wood rot, 64, 142, 281
- Lindera, 127
- Linnaea, 403
 black mildew, 48, 403
 leaf spot, 33, 403
 tar spot, 33, 403
- Linum, 225
- Lions-ear; *see* Leonotis
- Lions-tail; *see* Leonotis
- Lippia, 263
- Liquidambar, 412
- Liriodendron, 283
- Lithocarpus; *see* Tanbark-oak
- Lithospermum, 288
 leaf spot, 33, 181, 288
 mosaic, 57, 288
 powdery mildew, 41, 288
 root rot, 73, 231, 288
 rust, 45, 288
- Litsea, 127
- Liveforever; *see* Sedum
- Leafy-leaf, 112
 downy mildew, 41, 113
 leaf spot, 33, 112
 rust, 45, 112
 smut, 47, 113
- Lobelia, 281
 curly-top, 60, 282
 damping-off, 62, 281
 gray-mold blight, 38, 185, 282
 leaf smut, 50, 282
 leaf spot, 33, 282
 mosaic, 57, 281
 root-knot, 75, 282
 root rot, 73, 281
 rust, 45, 184, 282
 spotted wilt, 58, 140, 282
 stem and crown rot, 62, 281
- Loblolly-bay, 227
 black mildew, 48, 227
 leaf spot, 33, 227
 root rot, 73, 227
- Lobularia, 155
- Locust, 248
 canker, dieback, 63, 248
 chlorosis, 16, 17, 249, 285, 407
 damping-off, 62, 249
 leaf blight, 37, 249, 284
 leaf spot, 33, 249, 286
 mistletoe, 79, 249
 powdery mildew, 41, 248
 root-knot, 75, 249, 323
 root nematode, 248
- root rot, 73, 117, 248
 rust, 45, 249
 seedling blight, 62, 249, 333
 tree dip (black locust), 249, 429, 436
 verticillium wilt, 53, 249, 284
 witches'-broom, 249
 wood rot, 64, 142, 248
- Loganberry; *see also* Blackberry, Raspberry
- Lolium, 265
- London plane, 385; *see also* Sycamore
 anthracnose, 37, 385
 blight, cankerstain, 63, 64, 386
 canker, dieback, 63, 385, 386, 387
 leaf spot, 33, 386
 powdery mildew, 41, 386
 rosy canker, 63, 387
 tree dressing, 386
 twig blight, 63, 385, 387
 wood rot, 64, 142, 386
- Long-day plants, 27
- Lonicera, 371
- Loosestrife (*Lysimachia*), 344; *see also* Lythrum for Winged and Purple loosestrife
 leaf blight and stem necrosis, 344
 leaf spot, 33, 344
 root-knot, 75, 345
 root rot, 73, 344
 rust, 45, 345
 stem or crown rot, 62, 344
 stem nematode, 61, 345
- Loquat, 114; *see also* Apple
 anthracnose, 37, 120
 crown, collar rot, 62, 63, 119
 crown gall, 68, 117
 fire blight, 66, 70, 114
 flower blight, 66, 70, 114
 fruit spot or rot, 73, 118
 leaf blotch, 37, 120
 leaf spot, 33, 120
 root-knot, 75, 121
 root nematode, 121
 root rot, 73, 117
 scale, 50, 73, 115
- Lotus, 409
 leaf spot, 33, 409
- Love-lies-bleeding, 189; *see also* Amaranth
 aster yellows, 59, 136, 189
- Love vine, 80
- Luffa, 196
- Lunaria, 155
- Lupine, 311; *see also* Pea
 ascochyta blight, 37, 313
 crown gall, 68, 314
 damping-off, 62, 312
 downy mildew, 41, 313
 gray-mold blight, 38, 314
 leaf blight, 37, 314
 leaf nematode, 61, 315
 leaf spot, 33, 314
 mosaic, 57, 312
 powdery mildew, 41, 312
 ringspot, 58, 313
 root-knot, 75, 314
 root nematode, 314
 root rot, 73, 312
 rust, 43, 45, 312
 seed smut, 47, 315
- seed treatment, 312
 seedling blight, 62, 312
 southern blight, 62, 312
 spotted wilt, 58, 313
 stem or crown rot, 62, 63, 312, 313
- Lupinus, 311
- Lycaste, 302
- Lychnis, 169; *see also* Evening campion, Maltese cross, Mullen-pink, Red campion
 ringspot, 58, 170
- Lycium; *see* Matrimony-vine
- Lycopersicon, 389
- Lycoris, 204
 bulb rot, 75, 204
 leaf scorch or red spot, 37, 205
 root nematode, 205, 207
 stem and bulb nematode, 78, 205
- Lyonia, 145
 black mildew, 48, 147
 leaf blight or blotch, 35, 147
 leaf gall, shoot hypertrophy, 47, 146
 leaf spot, 33, 147
 powdery mildew, 41, 146
 rust, 43, 45, 146
 tar spot, 33, 147
 wood rot, 64, 147
- Lysimachia, 344
- Lythrum, 282; *see also* Loosestrife
 leaf spot, 33, 282
 root-knot, 75, 282
 root rot, 73, 183

M

- Maclura, 305
- Madeira-vine; *see* Boussingaultia
- Madrone, 145; *see also* Arbutus
 leaf blight or blotch, 37, 147
 red leaf gall, spot, 47, 146
 rust, 45, 146
- Magic lily; *see* Amaryllis
- Magnesium deficiency, 18
 sulfate, 18
- Magnolia, 283
 algal leaf spot, 283
 bacterial leaf spot, 35
 black mildew, 48, 283
 canker, 63, 283
 chlorosis, 16
 dieback, 63, 283
 felt fungus, 241, 283
 leaf spot, 33, 283
 petal rot, 70
 powdery mildew, 41, 283
 root-knot, 75, 283
 root nematode, 283
 root rot, 73, 117, 283
 seedling blight, 62, 283, 333
 sooty mold, 48, [49], 283
 spot anthracnose, 35, 283
 thread blight, 283, 409
 twig blight, 63, 283
 verticillium wilt, 53, 283, 284
 wood rot, 64, 142, 283
- Mahonia, 129; *see also* Oregon-grape
 canker, 63, 131
 leaf blotch, 35, 130

- Mahonia (*continued*)
 leaf spot, 33, 130
 root-knot, 75, 130
 root nematode, 131
 root rot, 73, 130
 rust, 45, 130
- Maidenhair-tree; *see* Ginkgo
- Maintenance
 dusters, 104
 sprayers, 100
- Malacothrix, 181
 rust, 45, 184
- Malanga; *see* Xanthosoma
- Malathion, 33, 50, 55, 57, 58,
 60, 62, 68, 70, 73, 83
 injury, 30
 in multipurpose mixes, 91
- Maleberry; *see* Lyonia
- Mallinckrodt Chemical Works,
 85, 106
- Mallow, 246
 anthracnose, 37, 246
 aster yellows, 59, 247
 crown gall, 68, 247
 curly-top, 60, 247
 leaf spot, 33, 246
 mosaic, 57, 247
 powdery mildew, 41, 247
 root rot, 73, 247
 rust, 45, 246
 seed treatment, 434
 spotted wilt, 58, 247
 stem canker, 63, 247
- Maltese cross, 169; *see also* Carnation
 flower smut, 47, 171
 gray-mold blight, flower
 blight, 38, 70, 170
 leaf spot, 33, 169, 170
 root rot, 73, 169
 rust, 45, 169
 stem rot, 62, 169
- Malus, 114
- Malva, 246
- Malvastrum, 246
- Mammillaria, 161; *see also* Cactus
 anthracnose, 36, 161
 root-knot, 75, 161
 root rot, 73, 161
 zonate spot, 33, 161
- Mammoth blackberry; *see* Blackberry, Raspberry
- Maneb
 gallon lots, 422
 in multipurpose mixes, 86, 91,
 419
 smog prevention, 29
 spray or dust, 33, 39, 41, 47,
 50, 70, 86, 419
 trade names and distributors,
 86, 419
 uses, 86, 419
- Manfreda, 178
 leaf spot, 33, 178
 rust, 45, 178
- Manganese chelates, 17
 deficiency, 17, 409
 ethylene bisdithiocarbamate,
 86, 419
- Mangel, 136; *see also* Beet
 bacterial soft rot, 68, 139
 boron deficiency, 17, 137
 crown gall, 68, 137
- crown rot, 62, 138
 curly-top, 60, 136
 damping-off, 62, 136
 heart rot, 17, 137
 leaf spot, 33, 136, 138
 mosaic, 57, 137
 root-knot, 75, 138
 root rot, 73, 138
 rust, 45, 138
 scab, 50, 138
 seed rot, 136
 seed treatment, 136, 431
 southern blight, 62, 138
 virus yellows, 59, 137
 yellow net, 57, 137
- Mangold, 136; *see also* Beet, Mangel
 crown gall, 68, 137
 mosaic, 57, 137
 seed rot, 136
 seed treatment, 136, 431
 virus yellows, 59, 137
- Manilagrass; *see* Zoysia
- Manure, 16
- Manzanita, 145
 black mildew, 48, 147
 leaf spot, 33, 147
 mistletoe, 79, 147
 red leaf spot, gall, 47, 146
 root rot, 73, 147
 rust, 45, 146
 shoot gall, hypertrophy, 47,
 146
 wood rot, 64, 147
- Manzate Maneb Fungicide, 86,
 419
- Maple, 284
 anthracnose, [36], 37, 284
 bacterial leaf spot, 35
 black mildew, 48, 286
 bleeding canker, 63, 135, 285
 canker, 63, 118, 135, 285
 chlorosis, 16, 285
 crown gall, 68, 117, 286
 dieback, 63, 285
 felt fungus, 241, 286
 inflorescence blight, 70
 leaf blight, 37, 284
 leaf blister, 47, 286, 316
 leaf scorch, physiological,
 [7], 28, 284
 leaf spot, 33, 286
 mistletoe, 70, 286
 powdery mildew, 41, 143, 286
 root nematode, 286
 root rot, 73, 117, 286
 seedling blight, 62, 286, 333
 slime flux or wetwood, 218,
 286
 sooty mold, 48, 286
 sunscald, 28, 119, 219, 286
 tar spot, 33, 286
 thread blight, 286, 409
 twig blight, 63, 285
 2,4-D injury, 237, 286
 verticillium wilt, 53, [54],
 284
 winter injury, 28, 119, 219,
 286
 wood rot, 64, 142, 285
- Maranta, 347
 leaf spot, 33, 347
 root-knot, 75, 347
 root nematode, 347
- rust, 45, 347
 Marbleseed, 288
 root rot, 73, 231, 288
 rust, 45, 288
- Marguerite, 181; *see also* Chrysanthemum, Camomile
 aster yellows, 59, 183
 crown gall, 68, 186
 curly-top, 60, 184
 damping-off, seed rot, 62, 183
 powdery mildew, 41, 183
 root-knot, 75, 134, 185
 seed treatment, 183
 verticillium wilt, 53, 141, 184
- Marigold, 181
 aster yellows, 59, [183]
 bacterial wilt, 55, 184
 damping-off, 62, 183
 flower spot, 70, 184
 fusarium wilt, 53, 184
 head blight, 38, 70, 184
 leaf spot, 33, 181
 mosaic, 57, 184
 root-knot, 75, 134, 185
 root nematode, 186
 root rot, 73, 183
 rust, 43, 45, 184
 seed treatment, 183
 southern blight, 62, 183
 stem or crown rot, wilt, 62,
 183, 184, 185
 verticillium wilt, 53, 141, 184
- Marine-ivy; *see* Cissus
- Mariposa lily; *see* Calochortus
- Marjorana, 362
- Marl, 17
- Marrubium, 362
- Mason jar, for treating seed,
 427
- Matricaria, 181
 aster yellows, 59, 183
 powdery mildew, 41, 183
 root-knot, 75, 134, 185
 rust, 45, 184
 white-rust, 47, 186
- Matrimony-vine, 286
 leaf spot, 33, 286
 mosaic, 57, 287
 powdery mildew, 41, 286
 rust 45, 287
- Matthiola, 155
- Maurandya, 368
 leaf spot, 33, 369
- Mayapple, 287
 gray-mold blight, 38, 287
 leaf blight, 37, 287
 leaf spot, 33, 287
 rust, 45, 287
 stem rot, 62, 287
- Mayday-tree; *see* Peach, Plum
- Mayflower; *see* Trailing-arbutus
- Meadowbeauty, 208
 leaf spot, 33, 208
- Meadowrue, 208
 downy mildew, 41, 210
 leaf spot, 33, 209
 leaf and stem smut, 47, 210
 powdery mildew, 41, 209
 rust, 43, 45, 210
 white smut, 50, 210
- Meadowsweet, 356; *see also* Spirea
 leaf spot, 33, 358
 powdery mildew, 41, 356

- rust, 45, 357
seedling blight, 62, 333
- Measurement**
sprays and dusts, 420-22
units of, 417
- Measuring apparatus**, 90
- Mecanopsis**, 338; *see also Poppy*
black mold, 48, 339
downy mildew, 41, 338
powdery mildew, 41, 339
stem canker or rot, 62, 63, 338
- Medlar**, 114; *see also Apple*
fire blight, 66, 114
leaf blight, spot, 33, 37, 120
- Melia**, 179
- Melissa**, 362
- Melon**; *see also Honeydew melon*, Muskmelon, Water-melon
fertilizing, 19
- Melothria**, 196; *see also Cucumber*
downy mildew, 41, 199
powdery mildew, 41, 199
root-knot, 75, 200
- Menispermum**, 290
- Mentha**, 362
- Mentzelia**, 287
leaf spot, 33, 287
root and stem rot, 62, 73, 287
rust, 45, 287
- Menziesia**, 145
leaf gall, 47, 146
leaf spot, 33, 147
powdery mildew, 41, 146
rust, 43, 45, 146
tar spot, 33, 147
- Mercuric chloride**, 25, 85, 427
disinfectant, 25, 66, 68, 70, 83, 303, 315
precautions, 85, 427
seed, bulb, tuber, rhizome treatment, 67, 254, 427-28
soil drench, 63, 68, 75, 254, 281, 311, 328, 405
uses, 85, 427
- Mercurous chloride**, 85
- Mercury**; *see Mercuric chloride*, Phenyl mercury
- Merrybells**; *see Bellwort*
- Mersolite**, 8, 205
- Mertensia**, 288
downy mildew, 41, 288
gray-mold blight, 38, 288
leaf smut, 50, 288
leaf spot, 33, 181, 288
mosaic, 57, 288
powdery mildew, 41, 288
rust, 43, 45, 288
stem rot, 62, 208, 288
- Mescalbean**; *see Sophora*
- Mesembryanthemum**, 253
- Mespilis**, 114
- Methanol**, crown gall treatment, 79, 407
- Methoxychlor**, 33, 50, 55, 58, 60, 68, 70, 73, 83
in multipurpose mixes, 91
- Methyl bromide**
mixture with chloropicrin, 443
precautions, 441, 443
- trade names, 443
uses, 443
- Mexican fire-plant**; *see Spurge*
- Mezereum**; *see Daphne*
- Michaelmas daisy**; *see Aster*, perennial
- Mico-Fume**, 443
- Micro Nu-Cop**, 88
- Microgel**, 88
- Micromeria**, 362
- Mignonette**, 289; *see Boussingaultia for Climbing mignonette*
aster yellows, 59, 289
black ringspot, 58, 159, 289
curly-top, 60
damping-off, 62, 289
downy mildew, 41, 289
leaf blight, 37, 289
leaf spot, 33, 289
root-knot, 75, 289
root rot, 73, 289
verticillium wilt, 53, 289
- Mildew**, black, 48
downy, 39, [40]
powdery, 41, [42]
- Mildew King**, 455
- Milk**, for virus control, 393
- Miller Chemical Company**, 106
- Miller Chemical & Fertilizer Corporation**, 89, 106
- Miller 658 Fungicide**, 455
Lime Sulfur Solution, 454
PCP-10, 456
- Miltonia**, 302
- Mimosa**; *see Sensitive plant*, "Mimosa" tree
"Mimosa" tree, 248
canker, dieback, 63, 248
fusarium wilt, 53, 249
leaf spot, 33, 249, 286
root-knot, 75, 249, 323
root nematode, 248
root rot, 73, 117, 248
- Mimulus**, 368
- Minnie-bush**; *see Menziesia*
- Mint**, 362
leaf spot, 33, 362
powdery mildew, 41, 363
rhizome or root soak, 363, 428, 434
root-knot, 75, 362
root nematode, 363
rust, 43, 362
spot anthracnose, 37, 362
stem canker, 63, 363
verticillium wilt, 53, 363
- Mirabilis**, 227
- Missouri primrose**; *see Evening-primrose*
- Mistflower**; *see Ageratum, Eupatorium*
- Mistletoe**, 78, [79]
- Mitchella**, 154
- Mitella**, 252
leaf rot, 37, 252
leaf spot, 33, 252
powdery mildew, 43, 252
rust, 45, 252
- Mites** as fungus carriers, 170
control, 33
as virus carriers, 11, 83, 321
- Mitrewort**; *see Mitella*
- Mock-cucumber**, 196; *see also Cucurbit*
anthracnose, 37, 73, 196
curly-top, 60, 199
downy mildew, 41, 196
fruit spot, 73, 200
fusarium wilt, 53, 198
leaf spot, 33, 197
mosaic, 57, 199
powdery mildew, 43, 199
seed treatment, 196
- Mock-strawberry**, 356
downy mildew, 39, 359
leaf spot, 33, 358
rust, 43, 357
- Mockorange**, 252
canker, dieback, 63, 253
flower and shoot blight (*Botrytis*), 38, 70, 252
leaf spot, 33, 252
powdery mildew, 43, 252
pruning, 21
root-knot, 75, 252
root nematode, 253
root rot, 73, 231, 253
rust, 43, 45, 252
sooty mold or blotch, 48, 253
wood rot, 64, 142, 253
- Molucella**, 362
- Molybdenum deficiency**, 18
- Momordica**, 196
- Monarda**, 362
leaf spot, 33, 362
mosaic, 57, 363
rust, 45, 362
southern blight, 62, 208, 363
verticillium wilt, 53, 363
- Monardella**, 362
leaf spot, 33, 362
rust, 45, 362
- Moneywort**; *see Loosestrife*
- Monkeyflower**, 368
aster yellows, 59, 370
leaf nematode, 61, 370
leaf spot, 33, 369
powdery mildew, 43, 369
rust, 45, 368
- Monkeypuzzle tree**, 122
- Monkshood**, 208; *see also Aconite*
bacterial leaf spot, 35, 209
leaf and stem smut, 47, 210
mosaic, 57, 209
rust, 45, 210
soil drench, 209
verticillium wilt, 53, 209
- Monkshood-vine**, 232; *see also Ampelopsis*
canker, dieback, 63, 240
downy mildew, 41, 237
powdery mildew, 43, 238
- Monoecious rust**, 43
- Monstera**, 162
leaf blight, spot, 33, 163
- Montbretia**; *see Tritonia*
- Moonflower**, 290
leaf nematode, 61, 185, 291
leaf spot, 33, 290
root-knot, 75, 291
root rot, 73, 291
rust, 43, 45, 290
white-rust, 47, 158, 290
- Moonseed**, 290
leaf smut, 50, 290

Moonseed (*continued*)

leaf spot, 33, 290
powdery mildew, 43, 290
Morning-glory, 290
blossom blight, 70, 291
curly-top, 60, 291
fusarium wilt, 53, 291
leaf spot, 33, 290
mosaic, 57, 291
root-knot, 75, 291
root rot, 73, 291
rust, 43, 45, 290
southern blight, 62, 290
stem canker, 63, 290
thread blight, 291, 409
white-rust, 47, 158, 290

Morton Chemical Company, 87,
89, 106, 419

Morus, 291

Mosaic, 55, [56], [59]

Moses-in-a-boat; *see Rhoea*

Mosquito bills; *see Shootingstar*

Moss campion; *see Silene*

Moss-pink; *see Phlox*

Mother-of-thyme; *see Thyme*

Mottle, 55

Moundlily; *see Yucca*

Mountain-ash, 114; *see also Apple*

black rot, canker, 33, 63, 116
blossom blight, 70, 114
canker, dieback, 63, 116, 118
crown gall, 68, 117
fire blight, 66, 70, 114
fruit spot or rot, 73, 118
leaf blight, 37, 120
leaf spot, 33, 120
powdery mildew, 43, 117
root rot, 73, 117
rust, 43, 45, 116
scab, 50, 115
sooty blotch, 48, 117
sunscald, 28, 119
twig blight, 63, 118
winter injury, 28, 119
wood rot, 64, 119

Mountain bluet; *see Centaurea*

Mountain-holly, 245; *see also Holly*

leaf spot, 33, 245
powdery mildew, 43, 245
tar spot, 33, 245
wood rot, 64, 142, 245

Mountain-laurel, 145

canker, 63, 147
chlorosis, 16, 147, [148], 352
drought injury, 147
flower blight, 70, 145
leaf blight, blotch, 37, 147, [148]

leaf spot, 33, 147, [148]
mummy berry, 145
powdery mildew, 43, 146
red leaf gall, spot, 47, 146
root rot, 73, 117, 147
tar spot, 33, 147
winter injury, 28, 147
witches'-broom, 146
wood rot, 64, 147

Mountain-mint, 362

leaf spot, 33, 362
powdery mildew, 43, 363
rust, 43, 362

Mountain spicewood, 164

Mountain spurge; *see Pachysandra*

Mugwort; *see Artemisia*

Mulberry, 291
bacterial spot, blight, 35, 291
canker, 63, 291
dieback, 63, 291
false mildew, 292
hairy root, 68, 117, 292
leaf spot, 33, 292
"popcorn" disease, 73, 292
powdery mildew, 43, 292
root-knot, 75, 292, 323
root rot, 73, 117, 292
rust, 43, 292
twig blight, 63, 291
wetwood or slime flux, 218, 292
wood, heart rot, 64, 292

Mulch, 16, 28, 29, 351

loose soil surface, 16
organic matter, 16
sunschorch, 28
winter protection, 29

Mullein, 368

downy mildew, 41, 369
leaf spot, 33, 369
powdery mildew, 43, 369
root-knot, 75, 369
root rot, 73, 369
soil drench, 369

Mullein-pink, 169; *see also Carnation*

aster yellows, 59, 170
leaf spot, 33, 170

Multipurpose sprays and dusts,
flowers, fruit, shrubs, trees,
vegetables, 91

Muscat, 399**Musk-melon**, 196; *see also Cucurbit*

angular leaf spot, 35, 197
anthracnose, 37, 196
aster yellows, 59, 200
bacterial leaf spot, 35, 197
bacterial soft rot, 68, 73, 200
bacterial wilt, 55, 197
chlorosis, 16, 201
crown gall, 68, 201
curling-top, 60, 199
damping-off, 62, 200
downy mildew, 41, 199
fruit rot, 73, 198, 200
fusarium wilt, 53, 198
gummy stem blight, 63, 200
leaf blight, 37, 197
leaf spot, 33, 200
mosaic, 57, 199
powdery mildew, 43, 199
ringspot, 58, 200
root-knot, 75, 200
root nematode, 200
root rot, 73, 132, 200
scab, 50, 197
seed treatment, 196, 427, 431
seedbed treatment, 200
southern blight, 62, 200
stem rot, 62, 63, 200
2,4-D injury, 201, 237
verticillium wilt, 53, 200

Mustard, 154; *see also Cabbage*

anthracnose, 37, 157

aster yellows, 59, 160

bacterial soft rot, 68, 157

bacterial spot, 35, 158

black rot, 35, 156

clubroot, [75], 156

crown rot, drop, 62, 158

curling-top, 60, 159

damping-off, 62, 155, 156, 157

downy mildew, 41, 157

fusarium wilt, 53, 155

leaf spot, 33, 157

mosaic, 57, 159

powdery mildew, 43, 160

ringspot, 58, 159

root-knot, root gall, 75, 134, 158

root rot, 73, 160

rust, 45, 160

seed treatment, 156, 428, 431
stem or crown rot, wilt, 62, 158

verticillium wilt, 53, 160

web blight, 134, 160

white-rust, 47, 158

Mylone, disinfecting soil, 77, 39, 443

Dust-50, 443

85% WP, 443

50% WP, 443

trade names, 443

25% WP, 443

uses, 443

Myosotis, 288

Myrica, 410

Myrtle, 292

leaf spot, 33, 292

powdery mildew, 43, 292

stem or crown rot, 62, 292

Myrtle boxleaf, 143

leaf spot, 33, 144

Myrtus, 292

N

Nabam, 270, 299

Nandina, 293

anthracnose, 37, 293

chlorosis, 16, 285, 293

leaf spot, 33, 293

root-knot, 75, 293

root nematode, 293

root rot, 73, 293

Nannyberry; *see Viburnum*

Narcissus, 204; *see also Daffodil*

bulb nematode, 77, 78, 205

bulb rot, 75, [76], 204, 206

bulb soak, 205, 206, 429, 430,

434

flower spot, 70, 205, 206

gray-mold blight, 38, 70, 205

leaf, stem, and bulb nem-

tode, 61, [206]

leaf blight, 37, 205

leaf scorch, 37, 205, [206]

mosaic, 57, 205

root nematode, 205, 207

smoulder, 37, [206]

white mold, 36, [206], 207

yellow dwarf, 207, 301

Nasturtium, garden; *see also Watercress*

aster yellows, 59, 294

bacterial leaf spot, 35, 293

bacterial wilt, 55, 293

- curly-top, 60, 294
 fasciation, 67, 294
 leaf spot, 33, 293
 mosaic, 57, 293
 ringspot, 58, 293
 root-knot, root gall, 75, 294
 rust, 45, 294
 seed treatment, 293, 429, 434
 spotted wilt, 58, 293
 stem rot, 62
- Natal-plum; *see* *Carissa*
 National Agricultural Chemicals Association, 90
Natriflora, 303
N-dure, 299, 339
Nectarina, 315; *see also* *Peach*
 asteroid spot, 321
 bacterial leaf spot, 35, 318
 blossom blight, 70, 315
 brown rot, 70, 73, 315
 canker, 63, 315, 318, 322
 crown gall, hairy root, 68, 322
 dieback, 63, 315, 322
 fruit rot, 73, 315, 318, 323
 leaf blight, 37, 323
 leaf curl, 47, 316
 mosaic, 57, 320
 peach yellows, 59, 319
 powdery mildew, 43, 322
 pruning, 21
 ringspot, 320
 scab, 50, 73, 318
 shot-hole, 37, 318, 322, 323
 spray schedule, 424-25
 twig blight, 63, 315, 322
 wood rot, 64, 142, 316
 X-disease, 318
- Needle blight (evergreens), 35-37
 cast (evergreens), 35-37
 rust, 43
- Nelumbo*, 409
Nemafume, 442
Nemagon, 73, 77, 89, 441, 444
Nemas; *see* *Nematodes*
Nematocides, 12, 440, 442-44
Nematodes, [10]-12
 bud, leaf, leaf gall, stem, 60, [61]
 bulb, ring disease, onion bloat, 77, [78]
 control, 12, 89, 440-44
 in home garden, 440
 dwarf or crimp, [61]
 identifying, 12
 losses due to, 12
 spread of, 11, 78
 types, 12
 virus carriers, 11, 240, 321, 394
 wounds for bacteria and fungi, 11, 73, 75
- Nemex* 85, 442
Nemex 40, 442
Nemopanthus; *see* *Mountain-holly*
Nemophilila, 327
 powdery mildew, 43, 327
Nepeta; *see* *Catnip*, *Ground-ivy*
Nephrolepis, 223
Nephthytis, 162
 cane rot, 37, 162
 leaf spot, 33, 163
- plant soak, 162, 429, 434
 root-knot, 75, 162
 root rot, 73, 162
- Nerine*, 204
Nerium, 298
Nettle, as virus source, 58
New Guinea bean; *see* *Cucurbit*
New Improved Ceresan, 233
New Jersey-tea, 294
 canker, dieback, 63, 118, 285, 294
 crown gall, 68, 117, 294
 leaf spot, 33, 294
 powdery mildew, 43, 294
 root rot, 73, 117, 294
 rust, 45, 294
 wood rot, 64, 142, 294
- New Zealand Spinach*, 136
cercospora leaf spot, 33, 136
 curly-top, 60, 136
 leaf spot, 33, 138
 mosaic, 57, 137
 ringspot, 58, 139
 root-knot, cyst nematode, 75, 138
verticillium wilt, 53, 139
 virus yellows, 59, 137
- Niagara Chemical Division, Food Machinery & Chemical Corporation*, 86, 87, 88, 89, 106, 419
- Niagara Phaltan 50 Wettable*, 88
Phyton, 86, 419
Seed Protectant, 86, 419, 430
- Nicandra*, 389
Nicotiana, 389
Nicotine sulfate, 57
 injury, 30
- Nierembergia*; *see* *Tomato*
Nightshade, 389; *see also* *Jerusalem-cherry*, *Eggplant*
 bacterial soft rot, 68, 391
 crown gall, 68, 397
 late blight, 37, 389
 mosaic, 57, 392
- Ninebark*, 294
 fire blight, 66, 114, 294
 leaf spot, 33, 186, 294
 powdery mildew, 43, 143, 294
 root rot, 73, 294
 wood rot, 64, 142, 294
- Nitrogen*, deficiency, 17
 injury, 17
- Norfolk island pine*, 122
Northern white-cedar; *see* *Arborvitae*
- Nothoscordum*, 299
Nu-Film, 104
Nuphar, 409
Nurseryman, 3, 20, 29, 82
Nutrient deficiencies, in plants, 17-18
The Care and Feeding of Garden Plants, 17
Hunger Signs in Crops, 17
- Nymphaea*, 409
Nyssa, 211
- O**
- Oak*, 295
 anthracnose, 37, 295, [297], 385
- bark patch, 298
 black mildew, 48, 297
 bleeding canker, 63, 135, 285, 298
 canker, dieback, 63, 285, 295, 297
 chlorosis, iron deficiency, 16, 285, 297
 crown gall, 68, 117, 297
 damping-off, 62, 333
 felt fungus, 241, 298
 leaf blight, 37, 295
 leaf blister or curl, 47, 295, [297]
 leaf scorch, physiological, 28, 297
 leaf spot, 33, 295
 lightning injury, 32
 mistletoe, 79, 298
 powdery mildew, 43, 297
 root nematode, 298, 323
 root rot, 73, 117, 297
 rust, 43, 45, 297
 seed (acorn) rot, 333
 sooty mold, 48, 297
 spot anthracnose, 37, 295
 twig blight, 63, 285, 295
 verticillium wilt, 53, 284, 298
 wetwood or slime flux, 218, 298
 wilt, 295, [296]
 wood, heart, or butt rot, 64, 142, 295
- The Oaks Manufacturing Company*, 98, 106
- Oceanspray*; *see* *Holodiscus*
Ocimum, 362
 mosaic, 57, 363
 root-knot, 75, 362
- Ocone-bells*, 228
 leaf spot, 33, 228
- Odontoglossum*, 302
- Oedema*, 28
 control of, 28
- Oenothera*, 221
- Oil*, dormant, injury, 30
- Okra*, 246
 anthracnose, 37, 246
 bacterial soft rot, 68, 246
 bacterial wilt, 55, 247, 395
 blossom blight, 70, 246
 curly-top, 60, 247
 damping-off, 62, 247
 dieback, 63, 246
 fusarium wilt, 53, 247
 leaf spot, 33, 246
 pod spot and rot, 38, 73, 246
 powdery mildew, 43, 247
 ringspot, spotted wilt, 58, 247
- root-knot, 75, 247
 root nematode, 247
 root rot, 73, 247
 rust, 45, 246
 seed treatment, 247, 431
 southern blight, 62, 247
 stem rot, 62, 247
 verticillium wilt, 53, 141, 247
 web blight, 134, 247
- Olea*, 305
Oleander, 298
 anthracnose, 37, 298
 bacterial knot or gall, 298
 canker, witches'-broom, 63, 298

- Oleander (*continued*)
 leaf spot, 33, 298
 root rot, 73, 117, 298
 sooty mold, 48, 298
 spot anthracnose or scab, 50, 298
- Olin Mathieson Chemical Corporation, 85, 89, 106
- Olive, 305
 anthracnose, 37, 305
 bacterial knot, 305, 322
 black mildew, 48, 305
 fruit spot, 73, 305
 leaf spot, 33, 305
 root-knot, 75, 305, 323
 root nematode, 305
 root rot, 73, 117, 305
 verticillium wilt, 53
- Oma-D, 442
- Omazene, 456
 gallon lots, 422
- Oncidium, 302
- Onion, 299
 aster yellows, 59, 302
 bacterial leaf streak, rot, 35, 302
 bacterial soft rot, 68, 73, 299
 blast, tip blight, 35, 38, 63, 300
 bloat (stem and bulb nematode), 61, 77, [78], 300
 bulb rot, 68, 73, 75, [76], 299
 chlorosis, 16-18
 damping-off, 62, 302
 downy mildew, 41, 300
 freezing injury, 302
 gray-mold rot, 38, 73, 75, 299
 leaf blight, 37, 299, 300, 302
 leaf spot, 33, 302
 mosaic, 57, 301
 neck rot, 73, 75, [76], 299
 pink root, 73, 300
 purple blotch, 37, 300
 root-knot, 75, 301
 root nematode, 302
 root rot, 73, 300
 rust, 45, 302
 scab, 50, 302
 seed, pelleted, 299
 seed treatment, 299, 432
 sour skin, scale rot, 299
 smudge, 73, 75, [301]
 smut, 47, [49], 299
 southern blight, 62, 302
 sunscald, 302
 verticillium wilt, 53, 302
 white rot, 73, 75, [76], 299
 yellow dwarf, 57, 301
- Onoclea, 223
- Onosmodium, 288
- Ophioglossum, 223
- Opuntia, 161; *see also* Cactus
 anthracnose, 36, 161
 bacterial soft rot, 68, 161
 black mildew, 48, 161
 cladode rot, spot, 161
 glassiness, 28, 161
 leaf scorch, 36, 161
 leaf spot, black, 33, 161
 oedema, 28, 161
 root-knot, 75, 161
 scab, 50, 161
 stem rot, 62, 161
- "sunscald," 161
- Orange, 187; *see also* Citrus
 Hardy orange
 anthracnose, wither tip, 37, 187
 bacterial blast, 33
 chlorosis, 16, 187
 crown gall, 68, 117, 187
 fruit rot, 73
 powdery mildew, 43
 root nematode, 187
 root rot, 73, 187
 scab, 50
 sooty blotch, 48, 187
 twig blight, 63, 187
- Orange sunflower; *see* Heliopsis
- Orchard Brand Ferbam, 86, 419
- Orchardist, 1, 3
- Orchards, spray requirements for, 426
- Orchids, 302
 anthracnose, 37, 303
 bacterial brown spot or rot, 35, 304
 bacterial soft rot, 68, 303
 black rot, 33, 37, 303
 black spot, 33, 303
 damping-off, 62, 303
 flower breaking, 57, 304
 fusarium wilt, 53, 304
 gray-mold blight, 38, 70, 303
 leaf blight or blotch, 37, 303
 leaf necrosis, 304
 leaf nematode, 61, 304
 leaf spot, 33, 303
 mold, 302
 mosaic, 57, 304
 mottle, 57, 304
 petal spot or blight, 70, 303
 plant soak, 305, 429, 434
 ringspot, 58, 304
 root nematode, 305
 root rot, 73, 303
 rust, 45, 303
 seed rot, 302
 seed treatment, 303, 434
 seedling blight, 62, 302, 303
 stem, collar, or crown rot, 62, 303
 tipburn, 305
- Oregon-grape, 129; *see also* Mahonia
 canker, 63, 131
 leaf blotch, 37, 130
 leaf scorch, scald, 28, 131
 leaf spot, 33, 130
 root-knot, 75, 130
 root nematode, 131
 root rot, 73, 130
 rust, 45, 130
- Organic matter, 16
- Organic mercury; *see* Phenyl mercury
- Organ-pipe cactus; *see* Cactus, Pachycereus
- Oriental orange; *see* Hardy orange, Citrus
- Ornamental allium, 299; *see also* Onion, Allium
- Ornithogalum, 399
- Orthex Spreader-Adhesive, 104
- Ortho
 Bordo Mixture, 88
- Copper Fungicide "53," 88
- D-D Soil Fumigant, 450
- 4 or 6 Dust, 87
- K, 88
- Lawn and Turf Fungicide, 89, 266, 267, 270
- Phaltan 50 Wettable, 88
- Rose Garden Fungicide, 88
- Spreader-Sticker, 104
- Zineb 75 Wettable, 87, 419
- Orthocide
 50 Wettable, 86, 419
 75, 430
 75 Seed Protectant, 86, 419, 430
- Fruit and Vegetable Wash, 86, 419
- Dieldrin 60-15 Seed Protectant, 430
- Karathane 50-6 Fungicide, 456
- Soil Treater "X," 85, 156, 442
- Orthoxiz Spray, 454
- Osage-orange, 305
 damping-off, 62, 305, 333
 leaf blight, 37, 305
 leaf spot, 33, 305
 mistletoe, 79, 305
 root rot, 73, 305
 rust, 45, 305
 verticillium wilt, 53, 284, 305
- Ozier; *see* Dogwood, Willow
- Osmanthus, 305
 black leaf spot, 33, 305
 black mildew, 48, 305
 leaf spot, 33, 305
 mistletoe, 79, 305
 root-knot, 75, 305, 323
 root rot, 73, 117, 305
 sooty mold, 48, 305
- Osmaronia, 356
- Osmorhiza, 175
- Osmunda, 223
- Osoberry, 356
 leaf spot, 33, 358
 powdery mildew, 43, 356
- Ostrya, 142
- Oswego-tea; *see* Monarda
- Oven, for treating soil, 437
- Oxalis, 306
 curly-top, 60, 136, 306
 leaf spot, 33, 306
 powdery mildew, 43, 306
 root rot, 73, 231, 306
 rust, 44, 45, 306
 seed smut, 47, 306
 stem nematode, 61, 306
 tar spot, 33, 306
- Oxeye; *see* Heliopsis
- Oxeye daisy, 181; *see also* Chrysanthemum
 aster yellows, 59, 183
 leaf nematode, 61, 185
 mosaic, 57, 184
 seed rot, damping-off, 62, 183
 seed treatment, 183
- Oxlip; *see* Primrose
- Oxybaphus, 227
- Oxydendrum, 373
- Oxygen deficiency, 26
- Oxyquinoline sulfate, 456
- Ozoban, 29
- Ozne injury, 29

P

- Pachistima, 143
 leaf spot, 33, 144
Pachycereus; *see Cactus, Cereus*
Pachysandra, 306
 canker, dieback, 63, 306
 leaf blight, 37, 306
 leaf spot, 33, 306
 root-knot, 75, 306
 root nematode, 306
Paeonia, 208
Pagoda-tree; *see Sophora*
Paint
 house, 25
 tree, 25
Painted-cup, 368
 powdery mildew, 43, 369
 rust, 45, 368
Painted-tongue, 389
 aster yellows, 59, 394
 fusarium wilt, 53, 394
 leaf blight, 35, 390
 powdery mildew, 43, 397
 root-knot, 75, 395
 root nematode, 395
 verticillium wilt, 53, 395
Pak-choi; *see Chinese cabbage*
Pale laurel; *see Mountain-laurel*
Palmetto, 307
Palms, 307
 anthracnose, 37, 307
 bacterial leaf spot, 35
 bacterial wilt, 55, 307
 black mildew, 48, 308
 black scorch, 37, 307
 bud rot, 307
 canker, gummosis, 63, 307
 chlorosis, manganese deficiency, 16, 17, 308, 409
 false smut, 307
 fruit spot, rot, 70, 73, 308
 gummosis, 307
 leaf blight, 37, 307
 leaf drop, 307
 leaf scab, 50, 307
 leaf scorch, withered leaf tip, 28, 308
 leaf spot, 33, 307, [308]
 root-knot, 75, 308
 root nematode, 308
 root rot, 73, 307
 sunscald, 28, 308
 thread blight, 308, 409
 trunk (stem) or butt rot, 64, 307
 wilt, 307
 wood rot, 64, 307
Pandanus, 365
Pano-Brome, 443
 CL, 443
 S, 443
Pano-drench 4, 82, 89, 335, 442
Panogen, seed treatment, 324
 Turf Spray, 89, 267
Panoram 75, 87, 419, 430
 D-31, 430
Pansy, 309; *see also Violet*
 anthracnose, 37, 309
 aster yellows, 59, 310
 calico, 57, 309
 crown, stem rot, 62, 68, 309
 curly-top, 60, 310
 damping-off, 62, 309
 downy mildew, 41, 309
 flower blight, 70, 309
 flower breaking, 57, 309
 fusarium wilt, 53, 309
 gray-mold blight, rot, 38, 70, 309
 leaf nematode, 61, 310
 leaf spot, 33, 309
 mosaic, 57, 309
 oedema, corky scab, 28, 309
 plant soak, 310, 429, 435
 powdery mildew, 43, 309
 ringspot, 58, 310
 root-knot, 75, 310
 root nematode, 310
 root rot, 73, 309
 rust, 45, 309
 seed smut, 47, 309
 seed treatment, 309, 434
 sooty mold, 48, 310
 southern blight, 62, 309
 spot anthracnose or scab, 50, [308], 309
Papaver, 338
Paper-mulberry, 224
 canker, dieback, 63, 118, 224
 leaf spot, 33, 224
 mistletoe, 79, 225
 root-knot, 75, 224, 323
 root rot, 73, 117, 224
Parasites, 8
Parasoltree; *see Phoenix-tree*
Parathion, injury, 30
Paris-daisy; *see Marguerite*
Parkinsonia, 248
 leaf spot, 33, 249, 286
 mistletoe, 79, 249
 root rot, 73, 117, 248
 sooty mold, 48, 249
Parsley, 175
 aster yellows, 59, 172, 176
 bacterial soft rot, 68, 176
 blackheart, heart rot, 176
 boron deficiency, 17, 18, 177
 crown rot, 62, 176, 177
 curly-top, 60, 136, 177
 damping-off, 62, 176
 downy mildew, 41, 173, 177
 fusarium wilt or yellows, 53, 176
 leaf blight, 37, 175
 leaf spot, 33, 175
 mosaic, 57, 176
 root-knot, 75, 176
 root nematode, 177
 root rot, 73, 177
 seed treatment, 176, 431
 stem nematode, 61, 78, 177
 stem rot, 62, 172, 176
 verticillium wilt, 53, 177
Parsnip, 171
 aster yellows, 59, 172
 bacterial soft rot, 68, 70, 172
 boron deficiency, 17, 173
 canker, 63, 172
 crown gall, 68, 173
 crown rot, 62, 73, 172
 curly-top, 60, 136, 173
 damping-off, 62, 172
 downy mildew, 41, 173
 gray-mold rot, 38, 172
 leaf spot, 33, 171, 172
 mosaic, 57, 173
 petiole rot, 37, 172
 powdery mildew, 43, 173
 ringspot, 58, 173
 root-knot, 75, 172
 root rot, 73, 172
 scab, 50, 138, 172, 339
 seed rot, 172
 seed treatment, 172, 432
 stem nematode, 61, 172
 storage rot, 73, 172
 watery soft rot, 73, 132, 172
 white-rust, 47
Parthenocissus; *see Boston ivy*,
 Virginia-creepers
Partridgeberry, 154
 black mildew, 48, 154
 stem rot, 62, 154
Parzate C, 87, 419
Zineb fungicide, 87, 419
Pasqueflower, 112
Passiflora, 310
Passionflower, 310
 anthracnose, 35, 310
 gray-mold blight, 37, 139, 310
 leaf spot, 33, 310
 root-knot, 75, 310
 root rot, 73, 310
 seedling wilt, 62, 310
 southern blight, collar rot, 52, 310
Pasteurization of soil; *see*
 Steam disinfection of soil
Pastinaca, 171
Patience plant, 129
Paulownia, 311
 leaf spot, 33, 311
 root rot, 73, 311
 wood rot, 64, 142, 311
Pawpaw, 311
 canker, dieback, 63, 311
 fruit rot, 70, 311
 leaf blotch, 37, 311
 leaf spot, 33, 311
 sooty mold, 48, 311
 wood rot, 64, 142, 311
PCNB; *see Terraclor*
Pea, garden, 311; *see also*
 Sweetpea
 anthracnose, 37, 314
 ascochyta blight, 37, 313
 bacterial blight, 35, 312
 bacterial soft rot, 68, 314
 bacterial wilt, 55, 314
 black walnut injury, 314
 blossom blight, 70, 314
 chlorosis, 16, 17, 18, 315
 damping-off, 62, 312
 downy mildew, 41, 313
 foot rot, 62, 312, 313
 fusarium wilt, 53, 311
 gray-mold blight, 38, 314
 leaf spot or blotch, 33, 313, 314
 light, effect on flowering, 27
 mosaic, 58, 312
 mottle, 58, 312
 mycosphaerella blight, 37, 313
 near wilt, 53, 311
 pod spot or rot, 68, 73, 313, 314

Pea (*continued*)

powdery mildew, 43, 312
ringspot, 58, 313
root-knot, cyst nematode, 75, 314
root nematode, 314
root rot, 73, [74], 311, 312
rust, 43, 45, 314
scab, 50, 314
seed rot, 312
seed treatment, 312, 430, 432
septoria blight, 37, 313
southern blight, 62, 312
spotted wilt, 58, 313
stem canker, 63, 312, 313
stem rot, 62, [74], 312, 313
streak, 312
stunt, 59, 312
temperature, effect on, 28
verticillium wilt, 53, 314
wilt (virus), 312
Pea-shrub; see Pea-tree
Pea-tree, 248
damping-off, seedling blight, 62, 249, 333
hairy root, 68, 211, 249
leaf blight, 37, 249, 284
leaf spot, 33, 229, 286
pod blight, 73, 249
root rot, 73, 117, 248
Peach, 315
asteroid spot, 321
bacterial leaf spot, 35, 318
bacterial shoot blight, 35, 66, 318
black knot, 66, 317
blossom blight, 66, 70, 315
brown rot, 70, 73, 315
canker, 63, 66, 315, [316], 318, 322
chlorosis, mottle leaf, 16-18, 285, 323, 407
coryneum blight, 37, 322
crown gall, hairy root, 68, [69], 322
dieback, 63, 315, 322
fly speck, 73, 323
fruit spot or rot, 37, 73, 315, 323
gummosis, 35, 66, 315, 318, 322
leaf blight, 37, 323
leaf curl, 47, [48], 316
leaf spot, 33, 323
little leaf, 17, 323, 407
little-peach, 319
mosaic, 57, 320
mottle, 57, 321
phony peach, 320
powdery mildew, 43, 322
pruning, 21
ringspot complex, 58, 320
root-knot, 75, 323
root nematode, 323
root rot, 73, 117, 323
rosette, 59, 319
rust, 45, 322
scab, 50, [51], 73, 318
shot-hole, 37, [38], 318, 322, 323
sooty mold, 48, 117, 323
spray schedule, 424-25
twig blight, 63, 315, 322

verticillium or blackheart
wilt, 53, 322
wet feet, 324
winter injury, 28, 323
wood rot, 64, 142, 316
X-disease, yellow-red disease, 318
yellows, [59], 319
Peanut, 324
bacterial wilt, 55, 325
chlorosis, manganese deficiency, 16, 17, 325
concealed damage, 73, 324
fusarium wilt, 53
gray-mold leaf rot, 38
Growing Peanuts, 324
hopperburn, 325
leaf mold, 324
leaf spot, 33, 324
mosaic, 57, 325
nematode injury, 324
pod, kernel decay, 73, 324
rust, 45, 325
seed mold, rot, 73, 324
seed treatment, 324, 432
seedling blight, 62, 324
southern blight, 62, 324
stem blight or rot, 53, 62, 63, 324
stunt, 59, 325
thrips injury, 325
verticillium wilt, 53, 325
white mold, 62, 324
Pear, 114; see also Apple
anthracnose, 37, 120
bacterial blast, 35, 114
bitter pit, 120
black end, 120
black rot, canker, 33, 63, 116
blossom blight, 38, 70, 114
boron deficiency, cork, drought spot, 17, 18, 121
brown core, heart, 120
canker, dieback, 63, 116, 118
chlorosis, 16, 121
crown gall, 68, 117
decline, 122
felt fungus, 122, 241
fire blight, [65], 66, 70, 73, 114
fly speck, 73, 117
fruit spot, rot, 68, 73, 118
leaf blight, 37, 120
leaf scorch, physiological, 28, 121
leaf spot, 33, 120
mistletoe, 79, 121
powdery mildew, 43, 117
pruning, 21
root-knot, 75, 121
root nematode, 121
root rot, 73, 117
rust, 45, 116
scab, 50, 73, 115
scald, 120
sooty blotch, 48, 73, 117
spot anthracnose, 37, 120
spray schedule, 424-25
stony pit, 120
sunscald, 28, 119
thread blight, 122, 409
twig blight, 38, 63, 118
wood rot, 64, 119, 142
zinc deficiency, 17, 121

Pearl everlasting, 181
leaf spot, 33, 181
rust, 45, 184
Peatmoss, 15, 16
acid, 16
Pecan, 406
anthracnose, 37, 406
boron deficiency, 17, 409
bunch disease, 406
crown gall, 68, 407
dieback, canker, 63, 407
downy spot, 41, 406
felt fungus, 241, 409
leaf scorch, 28, 409
leaf spot, 33, 406
mistletoe, 79, 409
“mouse ear,” manganese deficiency, 17, 409
nut mold or rot, 73, 408
powdery mildew, 43, 408
root-knot, 75, 409
root nematode, 408
root rot, 73, 117, 408
scab, 50, 70, 406, [407]
Spanish moss, 409
spray program, 406
sunscald, 28, 119, 219, 409
twig and trunk canker, 63, 407
winter injury, 28, 119, 219, 409
wood rot, 64, 142, 408
zinc deficiency, rosette, little leaf, 17, 407
Pelargonium, 231
Pellaea, 223
Penstemon, 368
black mildew, crust, 48, 371
leaf spot, 33, 369
mosaic, 53, 369
powdery mildew, 43, 369
root-knot, 75, 369
root rot, 73, 369
rust, 45, 368
seed treatment, 369
soil drench, 369
spotted wilt, 58, 370
stem or crown rot, spot, 62, 369
Pentachlorophenol, 456
Pentox, 456
Peony, 208
anthracnose, 37, 209
botrytis blight, 38, [39], 70, 208, 209, 210
bud blast, 38, 208, 210
chlorosis, 16, 210
crown elongation, 210
crown gall, 68, 140, 209
crown rot, 62, 208
flower blight, 70, 208, 210
leaf blotch, 37, 209
leaf curl, 211
leaf spot, 33, 209
leaf and stem nematode, 61, 210
LeMoine disease, 210
mosaic, 57, 209
oedema, measles, 28, 210
powdery mildew, 43, 209
ringspot, 58, 140, [210]
root-knot, 75, 209
root nematode, 209
root rot, 73, 208
root soak, 209, 429, 435

- soil drench, 208
 southern blight, 62, 208
 stem canker, 63, 208
 tip blight, 37, 208
 verticillium wilt, 53, 209
 witches'-broom, 210
- Peperomia*, 325
 anthracnose, 37, 163, 326
 corky scab, 28, 325
 cutting rot, 62, 326
 leaf spot, 33, 163, 326
 ringspot, 58, 325
 root nematode, 326
 root rot, 73, 326
 stem rot, 62, 326
- Pepper*, 389; *see also Tomato*
 anthracnose, 37, 73, 390
 aster yellows, 59, 394
 bacterial soft rot, 68, 73, 391, 392
 bacterial spot, 35, 73, 391, [392]
 bacterial wilt, 55, 395
 blossom blight or rot, 70, 397
 blossom drop, 28
 blossom-end rot, 73, 390
 chlorosis, 16-17, 396
 curly-top, 60, 394
 damping-off, 62, 395, 396
 downy mildew, 41, 396
 early blight, 37, 389
 fruit spot or rot, 68, 73, 389, 390, 391, 396
 fusarium wilt, 53, 394
 gray-mold rot, 38, 73, 390
 leaf mold, 390
 leaf spot, 33, 390
 milk, virus control, 393
 mosaic, 57, 392, 393
 phytophthora blight, 37, 396
 powdery mildew, 43, 397
 ringspot, 58, 394
 root-knot, 75, 395
 root nematode, 395
 root rot, 73, 396
 seed rot, 395
 seed treatment, 392, 427, 432
 seeded treatment, 395
 southern blight, 62, 396
 spotted wilt, 58, 393
 stem or collar rot, 62, 63, 389, 395, 396
 streak, 392
 sunscald, 28, 390
 verticillium wilt, 53, 395
 web blight, 37, 134, 397
- Pepperbush*; *see Clethra*
- Peppergrass*, 155; *see also Cabage*
 clubroot, 75, 156
 crown rot, 62, 158
 curly-top, 60, 159
 damping-off, 62, 156
 downy mildew, 40, 157
 leaf spot, 33, 158
 mosaic, 57, 159
 ringspot, 58, 159
 root rot, 73, 160
 rust, 45, 160
 stem and leaf nematode, 61
 white-rust, 47, 158
- Peppermint*; *see Mint*
- Peppertree*, 380
 root-knot, 75, 380
- root rot, 73, 117, 380
 verticillium wilt, 53, 380
 wood rot, 64, 142, 380
- Peppervine*, 232; *see also Am-pelopsis*
 leaf spot, 33, 237, 240
 thread blight, 240, 409
- P.E.P.S.*, 104
- Perennial pea*; *see Sweetpea*
- Periwinkle*; *see Vinca*
- Persea*, 127
- Persimmon*, 326
 anthracnose, 37, 284, 326
 canker, dieback, 63, 118, 285, 326
 cephalosporium wilt, 326
 crown gall, 68, 117, 326
 fly speck, 73, 326
 fruit spot or rot, 73, 326
 gray-mold rot, 38, 326
 leaf blotch, 37, 326
 leaf spot, 33, 326
 mistletoe, 79, 327
 powdery mildew, 43, 143, 326
 root-knot, 75, 323, 326
 root nematode, 326
 root rot, 73, 117, 326
 scab, 50, 326
 sooty blotch, 48, 117, 326
 tar spot, 33, 326
 thread blight, 326, 409
 twig blight, 63, 118, 285, 326
 verticillium wilt, 53, 326
 wood rot, 64, 142, 326
- Perunkila*; *see Carissa*
- Pesticide*; *see also Fungicide*
 application equivalents, 418
 chemicals, 82-92
 compatibility chart, 446
 distributors and manufacturers, 104, 106
 equipment, 92-103, 105
 fruit spray schedules, 423-25
 injury, 30
 laws, 90
 measuring apparatus, 90
 multipurpose mixes, 91
 precautions, 89-90, 423, 425, 427
 preparation of spray mixtures, 420-21
 purchasing, 85
 seed treatment, 427-36
 spreaders, 104
 spraying and dusting tips, 90-91
 stickers, 104
 wetting agents, 104
- Pestmaster*, 443
- Petal-fall spray*, 424
- Petroselinum*, 175
- Pet-tsai*; *see Chinese cabbage*
- Petunia*, 389
 aster yellows, 59, 394
 bacterial wilt, 55, 395
 curly-top, 60, 394
 damping-off, 62, 395
 early blight, 37, 389
 fasciation, 67, 314, 397
 flower breaking, 392
 fusarium wilt, 53, 394
 gray-mold blight, 38, 70, 390
- late blight, 37, 389
 leaf blotch, 37, 390
 leaf spot, 33, 390
 mosaic, 57, 392
 powdery mildew, 43, 397
 ringspot, 58, 394
 root-knot, 75, 395
 rust, 45, 397
 spotted wilt, 58, 393
 stem rot, 62, 395
 verticillium wilt, 53, 395
- Pfizer*, Charles & Company, Incorporated, 29, 89, 109
- Phacelia*, 327
 curly-top, 60, 327
 leaf spot, 33, 327
 mosaic, 57, 327
 powdery mildew, 43, 327
 rust, 45, 327
- Phalaenopsis*, 302
- Phaltan*
 gallon lots, 422
 soil drench, 82, 85, 354
 spray or dust, 39
 trade names and distributors, 88
 tree wound dressing, 386
 uses, 88
- Phaltan 50 Wettable*, 88
Phaltan 75-W, 88
- Phaseolus*, 131
- Phenol*, in tree wound dressing, 386
- Phenyl mercury*
phenyl mercuryacetate (PMA), 89
phenyl mercurychloride (PMC), 89
phenylmercury lactate(PML), 89
phenyl mercury nitrate (PMN), 89
phenylmercury monoethanol ammonium acetate, 89
 soil drench, 254
 trade names and distributors, 89
 in tree wound dressings, 25, 386
 uses, 89
- Philadelphia*, 252
- Philibertia*, 154
 powdery mildew, 43, 154
 rust, 45, 154
- Philodendron*, 162
 bacterial leaf and stem rot, 35, 37, 163
 cane or plant soak, 162, 163, 429, 435
 leaf spot, 33, 163
 leaf yellowing, dieback, 164
 root nematode, 162
 root rot, 73, 162
 sooty mold, 48, 164
 southern blight, 62, 162
 stem rot, 62, 162
- Phix*, 89
- Phlox*, 327
 aster yellows, 59, 328
 chlorosis, 16, 328, 358
 crown, stem rot, 62, 328
 crown gall, 68, 328
 downy mildew, 41, 328
 fasciation, 67, 314, 328

Phlox (continued)

gray-mold blight, 38, 185, 328
leaf blight, [36], 37, 327, 328
leaf drop, blight, 328
leaf nematode, 61, 185, 328
leaf spot, 33, 327
mosaic, 57, 328
powdery mildew, [42], 43, 327

root-knot, 75, 328

root rot, 73, 328

rust, 45, 328

soil drench, 328

southern blight, 62, 328

stem blight, canker, 63, 328

stem nematode, 328

streak, 328

verticillium wilt, 53, 328

Phoenix, 307

Phoenix-tree, 329

coral spot, twig canker, 63, 329

root rot, 73, 329

web blight, 134, 329

Phosphorus deficiency, 17

Photinia, 114; see also Apple

anthracnose, 37, 120

fire blight, 66, 114

leaf blight, 37, 120

leaf spot, 33, [115], 120

powdery mildew, 43, 117

root rot, 73, 117

rust, 43, 45, 116

scab, 50, [115]

twig blight, canker, 63, 118

Phyton, 86, 419

Naugets, 430

Seed Protectant, 86, 419, 430

Wettable Powder, 86, 419

-XL, 86, 419, 430

-XL Micronized, 86, 419

Phyla, 263

gray patch, 263

Phymatotrichum root rot, 73

Physalis, 389

Physocarpus, 294

Physostegia, 362

Phytomyzin, 88

Picea, 330

Picfume, 442

Pick-a-back plant, 329

Pieris, 112

Piggy-back plant, 329

powdery mildew, 43, 329

Pigweed, white-rust, 47

Pilea, 123

Pimpernel, 344

aster yellows, 59, 344

leaf spot, 33, 344

root-knot, 75, 345

Pimpinella, 175

Pincushion cactus; see Cactus, Mammillaria

Pincushion flower; see Scabiosa

Pine, 335

black mildew, 48, 333

brown felt blight, 334

canker, twig, branch, trunk, 63, 331

cytospora canker, 63, 331

damping-off, 62, 333

dieback, 63, 330, 333

gray-mold blight, 38, 333

leaf blight, 37, [330]

lightning injury, 32

mistletoe, dwarf, [79], 333

needle blight, cast, 37, [330]

needle scorch, 28, 333

pruning, 22

root-knot, 75, 323, 333

root nematode, 323, 333

root rot, 73, 117, 333

rust

blister, 45, [331]

gall, fusiform, 45, [332]

needle, cone, 45, 332

seed treatment, 333

seedling blight, 62, 333

shoot or tip blight, 330

snow blight, 334

soil drench, 333

sooty mold, 48, 333

sunschorch, 28, 334

tar spot, 33, 330

twig blight, 63, 330, 331

wind damage, 334

winter injury, needle scorch, 28, 333

wood rot, 64, 142, 330

Pinks, garden, 169; see also Carnation, Cushion-pink, Silene, Mullein-pink

anthracnose, 37, 170

curl-top, 60, 170

fusarium wilt, 51, 169

gray-mold blight, 38, 170

leaf spot, 33, 169, 170

leaf and stem nematode, 61, 171

mosaic, 57, 170

root-knot, 75, 171

root rot, 73, 169

rust, 45, 169

southern blight, 62, 169

stem rot, blight, 62, 63, 169

Pinus, 330

Pinxterbloom; see Azalea

Piqueria, 181

aster yellows, 60, 183

damping-off, 62, 183

fasciation, 67, 186

powdery mildew, 43, 183

root-knot, 75, 134, 185

root nematode, 186

seed treatment, 183

stem rot, 62, 183

Pistache; see Pistachio

Pistachio, 380

leaf spot, 33, 37, 380

root-knot, 75, 380

root rot, 73, 117, 380

thread blight, 381, 409

wood rot, 64, 142, 380

Pistacia, 380

Pisum, 311

Pittosporum, 334

leaf spot, 33, 334

mosaic, 57, 334

root-knot, 75, 323, 334

southern blight, 62, 334

stem or foot rot, 62, 334

thread blight, 334, 409

verticillium wilt, 53, 284, 334

Pittsburgh Plate Glass Company, 86, 89, 106, 419

Planetree, 385; see also London plane, Sycamore

anthracnose, 37, 385

canker, dieback, 63, 385, 386, 387

mistletoe, 79, 387

powdery mildew, 43, 386

twig blight, 63, 385, 387

wood rot, 64, 142, 386

Plant Cote, 29

Plant disease control, 81-106;

see also Control methods

hardiness zone map, 29

pathologist, extension, 34, 73,

108

Plantainlily, 251

Planting, 14-15

stock, in transmitting viruses,

11

Platanus, 385

Platycodon, 140

Plum, 315

asteroid spot, 321

bacterial leaf spot, black spot,

35, 318

bacterial shoot blight, gum-

mosis, 66, 318

black knot, [66], 317

blossom blight, 38, 70, 315

brown rot, 70, [72], 73, 315

chlorosis, 16-18, 285, 323, 407

crown gall, 68, 322

decline (virus complex), 60,

320

fire blight, 66, 114, 324

fruit spot or rot, 38, 73, 315,

318, 323

leaf blotch, 37, 323

leaf curl, 47, 316

leaf spot, shot-hole, 33, 317,

322

line pattern, 320

little-plum, 319

mistletoe, 79, 324

mosaic, 57, 320

phony peach, 320

pockets, 47, [48], 316

powdery mildew, 43, 322

prune dwarf, 60, 320

ringspot complex, 58, 320

root nematode, 323

root rot, 73, 117, 323

rosette, 60, 319

rust, 45, 322

scab, 50, 73, 318

shot-hole, 37, 318, 322, 323

sooty mold, 48, 117, 323

spray schedule, 424-25

tatterleaf, 320

thread blight, 324, 409

twig blight, 38, 63, 315, 322

verticillium wilt, 53, 322

witches'-broom, 47, 316

wood rot, 64, 142, 323

X-disease, 318

yellows, 60, 319

zinc deficiency, 17, 323, 409

Plum pockets, 47, [48]

Plum-yew; see Japanese plum-yew

Plumaris, 169

Plume hyacinth; see Virginia-

creeper, Grape-hyacinth

Plumed thistle, 181; see also

Thistle

inflorescence smut, 47

powdery mildew, 43, 183

- rust, 45, 184
 white-rust, 47, 186
Plumeria, 298
Plumy coconut, 307
Plunger-type duster, 100, [101]
Plyac Spreader-Sticker, 104
PMAS, 89
Poa, 265
Podocarpus, 414; *See also Yew*
 root nematode, 414
 root rot, 73, 414
Podophyllum, 287
Podranaea, 174
 root-knot, 75, 175, 323
Poinciana, 248; *see also Caesalpinia*
 anthracnose, 37, 249, 286
 canker, dieback, 63, 248
 crown gall, 68, 117, 249
 root rot, 73, 117, 248
 rust, 45, 249
Poinsettia, 335
 bacterial canker, leaf spot, 35, 336
 blossom blight, 38, 70, 336
 chlorosis, 16, 336
 crown gall, 68, 336
 gray-mold tip blight, stem canker, 38, 63, 336
 leaf spot, 33, 336
 light effect on flowering, 27
 root-knot, 75, 336
 root rot, 73, 335
 rust, 45, 184, 336
 soil drench, 335
 spot anthracnose or scab, 37, 50, 336
 stem or foot rot, 53, 62, 335
 wilt, 53, 335
Poker-plant; *see Redhot-poker plant*
Polemonium, 327
 fusarium wilt, 53, 328
 leaf spot, 33, 327
 powdery mildew, 43, 327
 rust, 45, 328
 verticillium wilt, 53, 328
Polianthes, 204
Pollen, as virus carrier, 11
Polyanthus; *see Primrose*
Polygala, 327
 anthracnose, 35, 327
 leaf spot, 33, 327
 rust, 45, 328
Polygonum, 367
Polyodium, 223
Polystichum, 223
Pomegranate, 336
 anthracnose, 37, 284, 336
 fruit spot or rot, 38, 73, 118, 336
 gray-mold rot, 38, 73, 336
 leaf blotch, 37, 336
 root-knot, 75, 336
 root rot, 73, 117, 336
 spot anthracnose, 37, 336
 thread blight, 336, 409
Poncirus, 187
Pond-spice, 127
 leaf spot, 33, 127
Pondlily, 409
 leaf spot, 33, 409
 white smut, 50, 409
Poormans-orchid; *see Butterfly-flower*
Popcorn; *see Corn*
Poplar, 337
 bacterial limb gall, 338
 branch gall, 338
 canker, dieback, 63, 337
 catkin deformity, 337
 chlorosis, iron deficiency, 16, 17, 285, 338
 crown gall, 68, 117, 338
 damping-off, 62, 333, 338
 ink spot, 33, 337
 leaf blister, yellow, 47, 337
 leaf blotch, 37, 337
 leaf spot, 33, 337
 lightning injury, 32
 mistletoe, 79, 338
 powdery mildew, 43, 337
 root nematode, 338
 root rot, 73, 117, 338
 rust, 43, 45, 337
 seed rot, 333, 338
 shoot blight, scab, 50, 337
 sooty mold, 48, 338
 spring leaf fall, 337
 verticillium wilt, 53, 284, 338
 wetwood or slime flux, 213, 337
 wood or butt rot, 64, 142, 337
Poppies, 338
 bacterial blight, 35, 338
 black ringspot, 159, 339
 curly-top, 60, 339
 damping-off, 62, 338
 downy mildew, 41, 338
 gray-mold blight, 38, 339
 leaf nematode, 61, 339
 leaf smut, 50, 339
 leaf spot, 33, 338
 powdery mildew, 43, 339
 root-knot, 75, 339
 root nematode, 339
 root and stem rot, 62, 73, 338
 seedpod spot, 338
 soil drench, 338
 spotted wilt, 58, 339
 verticillium wilt, 53, 338
Populus, 337
Porcelain berry; *see Ampelopsis*
Port Oxford cedar; *see Chamaecyparis*
Portulaca, 360
Possumhaw; *see Holly, Viburnum*
Pot marigold; *see Calendula*
Potassium deficiency, 17
Potato, 339
 aster yellows or purple-top, 60, 341
 bacterial soft rot, [67], 68, 73, 340
 bacterial wilt or brown rot, 55, 341
 black dot disease or anthracnose, 343
 black scurf (*Rhizoctonia*), 73, 342
 black walnut injury, 343
 blackheart, 342
 blackleg, [67], 68, 341
 calico, 57, 341
 canker, 63, 342
 corky ringspot, 341
 crinkle, 57, 341
 crown gall, 68
 curly-top or green dwarf, 60, 341
 early blight or target spot, 37, 339, [340]
 fertilizing, 19
 fusarium wilt or dry rot, 53, 341
 golden nematode, 342
 gray-mold blight, 38, 343
 hollow heart, 342
 hopperburn, 343
 knobbiness, 343
 late blight, 37, 340
 leaf scorch, 16-18, 343
 leaf spot, 33, 343
 leafroll, 341
 mosaic, 57, 341
 mottle, 57, 341
 powdery mildew, 43, 343
 psyllid yellows, 343
 ring rot, bacterial, 35, 342
 ringspot, 58, 341
 root-knot, 75, 342
 root rot, 73, 343
 root and rot nematodes, 342
 scab, common, 50, [51], 73, 339
 powdery, or canker, 343
 scurf, 73, 342
 seed-piece decay, 341
 seed-piece treatment, 341, 430, 432
 southern blight, 62, 343
 spindle tuber, 342
 stem or stalk rot, 62, 132, 341, 342, 343
 streak, 341
 tuber rot, 73, 340, 341, 342, 343
 vein banding, 341
 yellow dwarf, 341
 yellow spot, 341
 verticillium wilt, "pink eye," 53, 341
 web blight, 132, 343
 witches'-broom, 341
Potentilla, 356
 crown gall, 68, 357
 downy mildew, 41, 359
 fire blight, 66, 114, 360
 leaf blight, 37, 358
 leaf spot, 33, 358
 powdery mildew, 43, 356
 rust, 45, 357
Pothos, 162
 leaf spot, 33, 163
 root nematode, 162
 root rot, 73, 162
Powder-puff tree, 164
Powdery mildew, 41, [42]
Power duster, 104, [105]
 sprayer, [98], [99]
Practices; *see Cultural practices*
Prairie-coneflower, 181
 downy mildew, 41, 185
 leaf spot, 33, 181

- Prairie-coneflower (*continued*)
 powdery mildew, 43, 183
 root rot, 73, 183
 rust, 45, 184
 white smut, 50, 186
Prairie lily; *see* *Mentzelia*
Prairie rocket; *see* *Wallflower*, western
Prairiegentian, 230
 leaf spot, 33, 230
 root rot, 73, 231
 stem blight, 63, 231
Prayer plant; *see* *Maranta*
Prebloom spray, 424
Precautions, when handling pesticides, 89–90, 423
 treating seed, 427, 428
 treating soil, 437–44
 spraying fruit, 423, 425
Pressure cooker, for treating soil, 438
Pretty-face, 151
Prickly-ash, 250
 canker, dieback, 63, 250
 leaf spot, 33, 250
 mistletoe, 79, 250
 powdery mildew, 43, 250, 251
 rust, 45, 250
 sooty blotch, 48, 117, 250
 wood rot, 64, 142, 250
Prickly-poppy, 338
 downy mildew, 41, 338
 leaf spot, 33, 338
 root rot, 73, 338
 rust, 45, 339
Pricklypear; *see* *Cactus*, *Opuntia*
Primrose, 344
 anthracnose, 37, 344
 aster yellows, 60, 344
 bacterial leaf spot, 35, 344
 blackspot, 33, 344
 chlorosis, 16, 345
 damping-off, 62, 344
 downy mildew, 41, 344
 flower blight, 70, 344
 gray-mold blight, 38, 344
 leaf blight, 37, 344
 leaf spot, 33, 344
 leaf and stem nematode, 61, 345
 mosaic, 57, 344
 powdery mildew, 43, 183, 345
 root-knot, 75, 345
 root rot, 73, 344
 rust, 43, 45, 345
 spotted wilt, 58, 344
 stem rot, 62, 344
Primula, 344
Princesfeather; *see* *Amaranth*
Princesstree; *see* *Paulownia*
Privet, 345
 anthracnose, 37, 345
 canker, dieback, 63, 345
 chlorosis, 16, 285, 345
 chlorotic spot, 346
 crown gall, 68, 117, 345
 leaf blight, 37, 345
 leaf nematode, 61, 346
 leaf spot, 33, 345
 mosaic, 57, 346
 powdery mildew, 43, 345
 ringspot, 58, 346
 root-knot, 75, 323, 345
 root nematode, 345
 root rot, 73, 345
 sooty mold, 50, 345
 stem gall, 345
 thread blight, 346, 409
 twig blight, 63, 345
 variegation, 57, 346
 witches'-broom, 276, 346
 wood or collar rot, 64, 142, 345
Proboscidea, 346
Proboscisflower, 346
 bacterial leaf spot, 35, 346
 leaf spot, 33, 346
 mosaic, 57, 346
 root rot, 73, 346
 southern blight, 62, 346
 stem or crown rot, 62, 208, 346
Propagation, in transmitting viruses, 11
Protective seed treatment, 427–35
Prune; *see* *Plum*
Prunella, 362
 leaf spot, 33, 362
 powdery mildew, 43, 363
 root rot, 73, 231, 363
 southern blight, 62, 208, 363
 tar spot, 33, 362
Pruning, 20–23, [23], 28
 evergreens, 22
 hedges, 21
 in relation to buds, [21]
 shrubs, 21–22, [22]
 trees, 21–23, [23]
 correct procedure, 21–23, [23]
Prunus, 315
Pseudolarix, 264
Pseudotsuga, 330
Psidium, 292
Ptelea, 250
Pteretis, 223
Pteridium, 223
Pteris, 223
Puccoon; *see* *Lithospermum*
Pummelo; *see* *Citrus*; *Grapefruit*
Pumpkin, 196; *see also* *Cucurbit*
 angular leaf spot, 35, 197
 anthracnose, 37, 196
 aster yellows, 60, 200
 bacterial soft rot, 68, 200
 bacterial spot, 35, 201
 bacterial wilt, 55, 197
 blossom blight, 70, 201
 curly-top, 60, 199
 damping-off, 62, 200
 downy mildew, 41, 199
 fruit spot or rot, 68, 73, 172, 200
 fusarium wilt, 53, 198
 gray-mold rot, 38, 200
 leaf blight, 37, 197
 leaf spot, 33, 197
 mosaic, 57, 199
 powdery mildew, 43, 199
 ringspot, 58, 200
 root-knot, 75, 200
 root rot, 73, 132, 200
 scab, 50–197
 seed treatment, 196, 427, 431
 seedbed spray, 200
 southern blight, 62, 200
 stem rot, 62, 63, 200
 verticillium wilt, 53, 200
Punica, 336
Puratized, 205
 Apple Spray, 89
 root dip, 382
Pure Food and Drug Administration, 85
Purple coneflower, 181; *see also* *Echinacea*
 mosaic, 57, 184
Purple-flowered groundcherry, 389
 leaf spot, 33, 390
 powdery mildew, 43, 397
 rust, 43, 397
Purple loosestrife; *see* *Lythrum*
Purple osier; *see* *Willow*
Purple ragwort; *see* *Senecio*
Purple rockcress; *see* *Cabbage*, *Rockcress*
Purple smoke bush; *see* *Sumac*, and *Smoketree* for *Purple smoketree*
Purpleleaf bush; *see* *Peach*, *Plum*
Purpleleaf spiderwort; *see* *Rhoea*
Puschkinia; *see* *Tulip*
Pussytoes; *see* *Everlasting*
Pycnanthemum, 362
Pyracantha, 114; *see also* *Apple canker*, dieback, 63, 118
 felt fungus, 122, 241
 fire blight, 66, 114
 fruit spot or rot, 50, 73, 118
 leaf blight, 37, 120
 root rot, 73, 117
 scab, 50, 115
 thread blight, silky, 122, 409
 twig blight, 63, 118
Pyrethrum, 181; *see also* *Chrysanthemum*
 aster yellows, 60, 183
 damping-off, seed rot, 62, 183
 fasciation, 67, 186
 gray-mold blight, 38, 185
 leaf blight, 37, 181
 root-knot, 75, 134, 185
 root rot, 73, 183
 rosette, 60, 184
 seed treatment, 183
 stem rot, 62, 156, 183, 185
Pyrola, rust, 43
Pyrus, 114

Q

- Quaker bonnets*; *see* *Lupine*
Quamoclit, 290
Queen-of-the-meadow; *see* *Meadowsweet*
Queen-of-the-prairie; *see* *Meadowsweet*
Queens-delight, 173
 leaf spot, 33, 174
 root rot, 73, 117, 132, 174
 rust, 43, 45, 174
Quercus, 295
Quince, 114; *see also* *Apple*, Flowering quince
 anthracnose, 37, 120
 black rot, 33, 63, 73, 116
 blossom blight, 66, 70, 114

botrytis blight, rot, 38, 118
 brown rot, 70, 73, 118
 canker, dieback, 63, 66, 116,
 118
 crown gall, hairy root, 68, 117
 fire blight, 66, 70, 114
 fruit spot or rot, 73, 118
 gray-mold rot, 38, 118
 leaf blight, 37, 120
 leaf spot, 33, 120
 powdery mildew, 43, 117
 root-knot, 75, 121
 root nematode, 121
 root rot, 73, 117
 rust, 43, 45, 116
 scab, 50, 115
 spot anthracnose, 37, 120
 spray schedule, 424-25
 thread blight, 122, 409
 twig blight, 63, 118
 verticillium wilt, 53
 wood rot, 64, 119, 142
Quincula, 389

R

Rabbit tracks; *see Maranta*
Radish, 155; *see also Cabbage*
 aster yellows, 60, 160
 bacterial soft rot, 68, 73, 157
 bacterial spot, black rot, 33,
 156, 158, 160
 boron deficiency, 17, 18, 158
 clubroot, 75, 156
 crown gall, 68, 125, 160
 crown rot, 62, 73, 158
 curly-top, 60, 159
 damping-off, seedling blight,
 62, 63, 156
 downy mildew, 41, 157
 fusarium wilt, 53, 155
 leaf blotch, 37, 157
 leaf spot, 33, 157
 leaf and stem nematode, 61
 mosaic, 57, 159
 powdery mildew, 43, 160
 ringspot, 58, 159
 root-knot, 75, 134, 158
 root rot, 73, 157, 160
 rust, 43, 45, 160
 scab, 50, 73, 160
 seed treatment, 156, 428, 431
 verticillium wilt, 53, 160
 web blight, 134, 160
 white-rust, [46], 47, 156
Rainlily, 204
 leaf spot, 33, 207
 rust, 45, 207
Ranunculus, 208
Rape, 154; *see also Cabbage*
 anthracnose, 37, 157
 aster yellows, 60, 160
 black rot, 35, 156
 canker, 63, 155
 clubroot, 75, 156
 downy mildew, 41, 157
 gray-mold rot, 38, 70, 158
 leaf blight, 37, 157
 leaf spot, 33, 157
 mosaic, 57, 159
 powdery mildew, 43, 160
 ringspot, 58, 159
 root-knot, 75, 134, 158

scab, 50, 160
 seed treatment, 428, 431
 slimy soft rot, 68, 70, 157
 watery soft rot, 70, 158
 white-rust, [46], 47, 158
Raphanus, 155
Raspberry, 347; *see also Flowering raspberry*
 anthracnose, 37, [63], 347
 black mildew, 48, 350
 cane blight, dieback, 63,
 [348]
 cane and crown gall, hairy
 root, 68, [69], 348
 cane spot, 350
 canker, dieback, 63, 348
 chlorosis, 16, 285, 351, 409
 decline, 348
 downy mildew, 41, 351
 dwarf, 60, 348
 fire blight, flower blight, 66,
 70, 351
 fruit rot, spot, or mold, 38,
 73, 349
 gray-mold blight, 38, 70, 73,
 349
 leaf curl, 60, 348, [349]
 leaf rust, 45, 350
 leaf spot, 33, 350
 mosaic, 57, 348
 mottle, 57, 348
 necrosis, 348
 orange rust, 43, 45, 349
 powdery mildew, 43, 350
 root nematode, 350
 root rot, 73, 117, 350
 rosette, 60, 348
 spot anthracnose, 37, 347
 spray schedule, 424-25
 spur blight, 63, [348]
 streak, 348
 sunscorch, 28, 350
 verticillium wilt, 53, [54],
 350
 winter injury, 28, 350
 yellow rust, 45, 350
Ratibida, 181
Ray blight, 70, [71]
Red campion (*Lychnis*), 169;
 see also Carnation
 leaf spot, 33, 169, 170
 rust, 45, 169
Red-cardinal; *see Erythrina*
Red haw; *see Hawthorn*
Red-valerian, 403; *see also* Valerian
 leaf spot, 33, 403
Redbay, 127; *see also Avocado*
 black mildew, 50, 128
 dieback, 64, 127
 leaf spot, black leaf spot, 33,
 127
 root-knot, 75, 128
 wood rot, 64, 127, 142
Redbud, 248
 canker dieback, 64, 248
 crown gall, 68, 117, 249
 downy mildew, 41, 249
 leaf spot, 33, 249, 284
 root rot, 73, 117, 248
 2,4-D injury, [7], 237, 249
 verticillium wilt, 53, 249, 284
 wood rot, 64, 142, 248
Redcedar; *see Juniper*
Redhot-pokerplant, 351
 leaf spot, 33, 351
 root-knot, 75, 351
Redrobin, 194
Redtop, 265; *see also Bentgrass*
 anthracnose, 37, 265
 brown patch, 267
 copper spot, 270
 damping-off, 62, 271
 dollar spot, 267
 foot rot, 62, 265
 fusarium patch, 269
 leaf rot, 37, 265
 leaf scald, 37, 265
 leaf smut, 50, 270
 leaf spot, 33, 265
 powdery mildew, 41, 266
 root rot, 73, 265
 rust, 45, 266
 seed treatment, 271
 smut, 47, 270
 snow scald, 269
 tar spot, 33, 265
Redwood, 330
 bark canker, 331
 crown gall, 68, 334
 needle blight, 37, 330
 root rot, 73, 117, 333
 seed treatment, 333
 seedling blight, 38, 333
 soil drench, 333
 twig blight, 64, 330, 331
 wood rot, 64, 142, 330
Reseda, 289
Retinospora; *see Chamaecyparis*
Rhamnus, 152
Rheum, 355
Rhexia, 208
Rhizome rot, [62]
Rhododendron, 351; *see also Azalea*
 bud blast, 354
 canker, dieback, 64, 353, 354
 chlorosis, 16, 352
 crown or collar rot, wilt, 62,
 353
 damping-off, 62, 354
 flower gall, 47, 354
 flower spot, blight, 38, 70, 353
Growing Azaleas and Rhododendrons, 352
 leaf scorch, angular leaf spot,
 37, 351
 leaf and shoot gall, 47, 354
 leaf spot, 33, 351, [352]
 light requirements of, 27
 powdery mildew, 43, 354
 root-knot, 75, 353
 root nematode, 353
 root rot, 73, 353
 rust, 43, 45, 354
 seedling blight, 38, 62, 354
 shoot blight, 38, 351
 sooty mold, 50, 354
 spot anthracnose, 37, 351
 sunscald, leaf burn, 28, 352
 thread blight, 354, 409
 twig blight, 64, 353, 354
 winter injury, 28, 352
 witches'-broom, 47, 354
 yellow spot, 47, 354
Rhodora; *see Azalea*
Rhodotypos, 259

- Rhœa, 354
 crown rot, 62, 109, 354
 root-knot, 75, 110, 354
 root rot, 73, 109, 354
Rhubarb, 355
 anthracnose, 37, 355
 bacterial soft rot, crown rot, 35, 68, 355
 bacterial wilt, 55, 355
 cracked stem, boron deficiency, 177, 355
 crown gall, 68, 355
 crown rot, 62, 64, 355
 curly-top, 60, 355
 damping-off, 62, 355
 downy mildew, 41, 355
 gray-mold rot, 38, 355
 leaf spot, blight, 33, 37, 355
 mosaic, 57, 355
 ringspot, 58, 355
 root-knot, cyst nematode, 75, 355
 root nematode, 355
 root rot, 73, 355
 rust, 45, 355
 southern blight, 62, 355
 stalk spot or rot, 62, 64, 355
 stem nematode, 61, 355
 verticillium wilt, 53, 355
- Rhus**, 380
- Ribes**, 201
- Ricinus**, 173
- Ring disease**, 77, [78]
- Ringspot**, 57, [58]
- Rivina**, 360
- Robinia**, 248
- Rocaea**; *see Crassula*
- Rockcress**, 155; *see also Cabbage*
 clubroot, 75, 156
 damping-off, 62, 156
 downy mildew, 41, 157
 gray-mold blight, 38, 158
 leaf spot, 33, 157
 root-knot, 75, 134, 158
 root rot, 73, 160
 rust, 45, 160
 white-rust, 47, 158
- Rocket**; *see Damesrocket*
- Rockjasmine**, 344
 downy mildew, 41, 344
 leaf spot, 33, 344
 rust, 45, 345
- Rockspirea**; *see Holodiscus*
- Rocky mountain garland**; *see Clarkia*
- Rohm & Haas Company**, 85, 86, 87, 106, 419
- Rollinia**, 311
 dieback, 63, 311
 fruit rot, 73, 311
- Romanzoffia**, 327
 rust, 45, 327
- Root diseases**, 73-78
 gall (nematode), 75
 -knot nematode, 12, 75, [77], 323
 and root rots, wilt, 75
 rot, 10, 12, 73, [74], 117
- Root-Lowell Corporation**, 95, 106
- Root weevil**, 415
- Rootone F**, 458
- Rorippa**; *see Watercress*
- Rosa**, 356
- Rosarypea**, 311; *see also Pea*
 root-knot, 75, 314
- Rose**, 356
 bacterial leaf spot or blast, 35, 358
 black mold, 359
 blackspot, 33, [34], 356, 358
 blossom blight, 38, 70, 358
 bud drop, 17
 cane blight, 64, 357
 canker, [63], 64, 357
 chlorosis, 16, 358
 crown or collar rot, 62, 358, 360
 crown or stem gall, hairy root, 68, [69], 357
 dieback, 64, 357
 downy mildew, 41, 359
 fertilizing, [21]
 fire blight, 66, 114, 360
 gray-mold blight, 41, 70, 358
 infectious chlorosis, 358
 leaf spot, 33, 358
 mosaic, 57, 358, [359]
 powdery mildew, [42], 43, 356
 root-knot, 75, 359
 root nematode, 359
 root rot, 73, 358
 rosette, 358
 rust, 43, 45, [357]
 southern blight, 62, 360
 spot anthracnose, 37, 356, 358
 storage decay, 62, 358
 storage treatment, 435
 streak, 358
 thread blight, 360, 409
 2,4-D injury, 237, 360
 verticillium wilt, 53, 358
 winter injury, 28, 358
 protection, 358
- Rose campion**; *see Red campion*
- Rose-mallow**, 246
 crown gall, 68, 247
 damping-off, 62, 247
 dieback, 37, 64, 246
 leaf spot, 33, 246
 pod spot, 246
 root-knot, 75, 247
 root rot, 73, 247
 rust, 45, 246
 seed treatment, 247
- Rose-of-Heaven**; *see Maltese cross, Carnation*
- Rose-moss**, 360
 curly-top, 60, 360
 damping-off, 62, 136, 360
 root-knot, 75, 360
 seed rot, 360
 white-rust, 47, 360
- Rose-of-Sharon**, 246; *see also Hibiscus (arborescent forms)*
 bacterial spot, 35, 246
 blossom blight, 70, 246, 247
 gray-mold blight, 38, 246
 pruning, 21
 rust, 45, 246
- Rose tree of China**; *see Peach*
- Rosebay**; *see Rhododendron*
- Roselle**, 246
 anthracnose, 37, 246
 blossom blight, 70, 246
- damping-off, 62, 247
 dieback, 63, 246
 gray-mold blight, 38, 246
 leaf spot, 33, 246
 pod spot or rot, 246
 powdery mildew, 43, 247
 root-knot, 75, 247
 root rot, 73, 247
 seed treatment, 247
 southern blight, 62, 247
 stem rot, 62, 247
- Rosemary**, 362
 root rot, 73, 231, 363
- Rosette**, 58
- Rosinweed**; *see Golden-aster*
- Rosmarinus**, 362
- Rot**
 bacterial soft, [67]
 bacterial stem, 67
 berry, 70
 blossom, 37, 70
 brown rot (bacterial), 55
 bud, 33, 37
 bulb, 75
 butt, 64
 collar, 62, 67
 corm, 75
 crown, 62
 cutting, 73
 foot, 62
 fruit, 70, [72]
 heart, 64
 inflorescence or ray, 70
 rhizome, 62, 75
 root, [72], [74]
 sapwood, 64
 seed, 70
 stalk, 62
 stem, 62, 67
 storage, 70
 tuber, 70
 wood, [64], 74
 wound, 64
- Rot-Not**, 449
- Rotary-fan duster**, 100, 104
- Rotation**; *see Crop rotation*
- Rotenone**, 83
 in multipurpose mixes, 91
- Rougeplant**, 360
 leaf spot, 33, 360
 root nematode, 360
 root rot, 73, 231, 360
 rust, 45, 360
- Rowantree**; *see Mountain-ash*
- Roystonea**, 307
- Rubber plant**, 224; *see also Fig*
 anthracnose, 37, 224
 canker, dieback, 63, 118, 224
 crown gall, 68, 140, 224
 leaf scorch, fall, 28, 224
 leaf spot, 33, 224
 low humidity, 28
 oedema, 28, 225
 root-knot, cyst nematode, 224, 323
- Rubus**, 347
- Rudbeckia**, 181
 aster yellows, 59, 183
 downy mildew, 41, 185
 leaf spot, 33, 181
 mosaic, 57, 184
 powdery mildew, 43, 183
 root rot, 73, 183
 rust, 45, 184

southern blight, 62, 183
 verticillium wilt, 53, 141, 184
 white smut, 50, 186
 yellow dwarf, 59, 184
Rue anemone, 112
 leaf spot, 33, 112
 powdery mildew, 43, 113
 rust, 45, 112
 smut, 47, 113
Ruellia, 188
 leaf spot, 33, 188
 root rot, 73, 189
 rust, 45, 188
Russian-olive, 361
 canker, dieback, 64, 285, 361
 crown gall, hairy root, 68, 117, 361
 leaf spot, 33, 361
 mistletoe, 79, 361
 powdery mildew, 43, 361
 root rot, 73, 117, 361
 rust, 45, 361
 seedling blight, 62, 333, 361
 thread blight, 361, 409
 trunk canker, 64, 316
 verticillium wilt, 53, 284, 361
 wood rot, 64, 142, 361
Rust, 10, 43, [44]
 autoecious, 43
 heteroecious, 43
 leaf, stem, needle, 43
 white-, [46], 47
Rustyleaf; *see* Menziesia
Rutabaga, 154; *see also* Cabbage
 anthracnose, 37, 157
 aster yellows, 60, 160
 bacterial leaf spot, 35, 158
 bacterial soft rot, 68, 73, 157
 black rot, 35, 156
 blackleg, 64, 155
 boron deficiency, 17, 18, 158
 clubroot, 75, 156
 crown gall, 68, 125, 160
 curly-top, 60, 159
 downy mildew, 41, 157
 fusarium wilt, 53, 155
 gray-mold rot, 38, 158
 leaf spot, 33, 157
 mosaic, 57, 159
 powdery mildew, 43, 160
 root-knot, 75, 134, 158
 root nematode, 160
 root rot, 73, 160
 scab, 50, 160
 seed treatment, 156, 428, 431
 verticillium wilt, 53, 160
 watery soft rot, 73, 158
 white-rust, 47, 158
Ryegrass, 265; *see also* Blue-grass
 anthracnose, 37, 265
 bacterial spot, 33
 brown patch, 267
 cottony blight, 269
 leaf blight, blotch, or scald, 37, 265
 leaf spot, 33, 265
 red thread or pink patch, 270
 root nematode, 269
 root rot, 73, 265
 rust, 45, 266
 smut, 47, 270
 snow scald, 269

S

Sabal, 307
Safety, when handling pesticides, 89–90
Safflower, 181
 anthracnose, blight, 37, 181
 crown or stem rot, 62, 183, 185
 gray-mold blight, 38, 185
 leaf spot, 33, 181
 root-knot, 75, 134, 185
 root rot, 73, 183
 rust, 45, 184
 seed treatment, 183, 185, 435
 verticillium wilt, 53, 141, 184
Sage; *see* Salvia
Saguaro, 161; *see also* Cactus, Cereus
 bacterial blight, 161
 crown gall, 68
 dry rot, 62, 161
St.-Andrews-cross; *see* St.-Peter's-wort
St. Augustine grass, 265; *see also* Bluegrass
 brown patch, 267
 dollar spot, 267
 foot rot, 62, 265
 grayleaf spot, 33, 270
 leaf spot, blotch, 33, 265
 root nematode, 269
 rust, 45, 266
 slime mold, 267
St.Johns-fire; *see* Salvia
St.Johns-wort, 362
 leaf spot, 33, 362
 powdery mildew, 43, 362
 root-knot, 75, 362
 rust, 45, 362
 stem spot, 362
St.Peters-wort, 362
 leaf spot, 33, 362
 rust, 45, 362
Saintpaulia, 109
Salad chervil; *see* Chervil
Salal, 243
 black mildew, 50, 243
 leaf spot, 33, 243
 powdery mildew, 43, 243
 spot anthracnose, 37, 243
Salix, 411
Salmonberry; *see* Blackberry, Raspberry
Salpiglossis, 389
Salsify, 272; *see also* Black-salsify
 aster yellows, 60, 273
 bacterial soft rot, 68, 272
 curly-top, 60, 275
 leaf blight, 37, 274
 leaf spot, 33, 274
 leaf and stem nematode, 61, 275
 powdery mildew, 43, 274
 root-knot, 75, 134, 275
 root nematode, 275
 root rot, 73, 274
 rust, 45, 274
 scab, 50, 275
 seed rot, 274
 seed treatment, 274, 431
 southern blight, 62, 272
stem rot, 62, 272
 verticillium wilt, 53, 275
 white-rust, 47, 275
Salt injury, 29–30
 excess soluble salts, 19
Salvia, 362
 aster yellows, 60
 damping-off, 62, 208, 363
 downy mildew, 41, 363
 leaf nematode, 61, 363
 leaf spot, 33, 362
 mosaic, 57, 363
 powdery mildew, 43, 363
 root-knot, 75, 362
 root nematode, 363
 root rot, 73, 231, 363
 rust, 45, 362
 southern blight, 62, 208, 363
 spotted wilt, 58
 stem rot, 62, 208, 363
Sambucus, 371
Sanchezia, 188
 root rot, 73, 189
Sand-verbena, 227
 downy mildew, 41, 227
 leaf spot, 33, 227
 rust, 43, 45, 227
Sandmyrtle; *see* Box sandmyrtle
Sandwort, 169
 powdery mildew, 43, 171
Sanguinaria, 338
Sanguisorba, 356
Sanitation, 33, 37, 39, 41, 43, 47, 48, 50, 53, 55, 57, 58, 61, 62, 63, 64, 66, 67, 68, 70, 73, 75, 78, 80, 83
Sansevieria, 364
 bacterial soft rot, 68, 364
 cutting rot, 62
 leaf spot, 33, 364
 plant soak, 364, 429, 435
 root-knot, 75, 364
 root nematode, 364
Santomerse, 104
Sapindus, 372
Sapium, 173
Sapwood rot, 64
Sarsaparilla, 108
 leaf spot, 33, 108
 powdery mildew, 43, 108
 rust, 45, 108
Sassafras, 127
 canker, dieback, 64, 127
 leaf spot, 33, 127
 mistletoe, 79, 128
 mosaic, 57
 powdery mildew, 43, 128
 sooty blotch, 50, 128
 verticillium wilt, 53, 128
 wood rot, 64, 127
 yellows, 60, 128
Satin-flower, 228; *see also* Godelia
 aster yellows, 60, 183, 228
 rust, 45, 228
 spotted wilt, 58, 140, 228
Sawara-cypress; *see* Chamaecyparis
Saxifrage, 252
Saxifrage, 252
 leaf spot, 33, 252
 powdery mildew, 43, 252
 rust, 45, 252
Scab, 10, 50, [51]

- Scabiosa**, 364
 aster yellows, 60, 364
 black ringspot, 58, 159, 364
 curly-top, 60, 364
 leaf spot, 33
 mosaic, 55
 powdery mildew, 43, 364
 root rot, 73, 231, 364
 southern blight, 62, 364
 stem or crown rot, 62, 364
Scales, secreting "honeydew," 48
Scarborough-lily, 204
 leaf scorch or red spot, 37, 205
Scarlet eggplant; *see* Jerusalem-cherry, Eggplant
Scarlet pimpernel; *see* Pimpernel
Scarlet runner bean, 131; *see also* Bean, garden types
 anthracnose, 37, 132
 bacterial blight, 33, 131
 leaf spot, 33, 134
 powdery mildew, 43, 133
 root rot, 73, 132
 rust, 45, 132
Schefflera, 364
 leaf spot, 33, 364
 root-knot, 75, 364
Schinus, 380
Schizanthus, 389
 leaf and stem nematode, 61, 397
Schlumbergera, 161
Scholar-tree; *see* Sophora
Sciadopitys, 330
Scilla, 399
Scindapsus, 162
Sclerotia, 10
Scorch, 28
Scorpionweed; *see* Phacelia
Scorzonera, 272
Scotch broom; *see* Broom
Scotch laburnum, 236
Screwpine, 365
 burrowing nematode, 323, 365
 leaf spot, 33, 365
Scurvyweed, 155; *see also* Cabbage
 white-rust, 47, 158
Scutellaria, 362
Sea holly; *see* Eryngium
Sea-lavender, 365
 aster yellows, 60, 365
 flower blight, 70, 365
 gray-mold blight, 38, 365
 leaf spot, 33, 365
 root-knot, cyst nematode, 75, 365
 root rot, 73, 231, 365
 rust, 45, 365
 spotted wilt, ringspot, 58, 365
Sea-pink; *see* Armeria
Sea-urchin cactus; *see* Cactus *Echinocactus*
Seakale, 155; *see also* Cabbage
 bacterial blight, 35, 156
 clubroot, 75, 156
 fusarium wilt or yellows, 53, 155
 mosaic, 57, 159
Sechium, 196
- Sedum**, 366
 fusarium wilt, 53, 366
 leaf blotch, 37, 366
 leaf spot, 33, 366
 root-knot, 75, 366
 rust, 45, 366
 soil drench, 366
 southern blight, 62, 366
 stem or crown rot, 62, 366
Seed rot, 70
 smut, 47
 treatment, 427-36
 advantages, 427
 eradication, 427-36
 hot water, 428-29
 protective, 427-35
 precautions, 427
 types of, 427
 as virus carriers, 11
Seedling blight, 37, 40, 333
Selheal; *see* Prunella
Semesan, disinfectant, 303
 gallon lots, 422
 seed, bulb, corm, rhizome, tuber treatment, 254, 430
 soil application, 82, 335, 405, 442
Semesan Bel, disinfectant, 342
 tuber or root dip, 341, 382, 430
Sempervivum, 366
Senecio, 181
 aster yellows, 58, 183
 damping-off, seed rot, 62, 183
 downy mildew, 39, 185
 fusarium wilt, 53, 184
 gray-mold blight, 37, 185
 leaf nematode, 61, 185
 leaf spot, 33, 181
 mosaic, 55, 184
 powdery mildew, 41, 183
 root-knot, 75, 134, 185
 root rot, 73, 183
 rust, 43, 45, 184
 seed treatment, 183
 spotted wilt, 57, 184
 stem rot, 62, 183
 verticillium wilt, 53, 141, 184
 white-rust, 47, 186
 white smut, 50, 186
Senna; *see* Cassia
Sensitive plant, 311
 leaf spot, 33, 314
 root rot, 73, 312
 rust, 45, 314
Sequestrone, 270, 285
Sequoia, 330
 bark canker, 331
 needle blight, 37, 330
 root rot, 73, 117, 333
 seed treatment, 333
 seedling blight, 62, 333
 soil drench, 333
 twig blight, 38, 64, 330, 331
 wood rot, 64, 142, 330
Serviceberry, 114; *see also* Amelanchier, Apple
 black mildew, 49, 120
 blossom blight, 70, 114
 canker, 64, 118
 dieback, 64, 118
 fire blight, 66, 114
 fruit rot, 70, 118
 leaf blight, 36, 118
- leaf blister, 47, 122
 leaf spot, 33, 120
 powdery mildew, 43, 117
 root rot, 73, 117
 rust, 44, 116
Servicetree; *see* Mountain-ash
Sevin, 83
Shadblow; *see* Serviceberry, Amelanchier
Shadblow; *see* Serviceberry, Amelanchier
Shallot; *see* Salal
Shallot, 299; *see also* Onion
 aster yellows, 60, 302
 bacterial soft rot, 68, 75, 299
 bulb nematode, 78, 300
 bulb rot, 68, 75, 299
 clove or bulblet treatment, 299, 300, 428, 432
 downy mildew, 41, 300
 fusarium root rot, 73, 300
 gray-mold, 38, 75, 299
 mosaic, 57, 301
 neck rot, 75, 299
 pink root, 73, 300
 purple blotch, 37, 300
 root-knot, 75, 301
 root rot, 73, 300
 rust, 45, 302
 smudge, 75, 301
 smut, 47, 299
 southern blight, 62, 302
 white rot, 75, 299
Shamrock; *see* Oxalis
Shasta daisy (*Chrysanthemum maximum*), 181; *see also* Chrysanthemum
 crown gall, 68, 186
 curly-top, 60, 184
 fasciation, 67, 186
 leaf blotch, 37, 181
 leaf spot, 33, 181
 root-knot, 75, 134, 185
 root rot, 73, 183
 stem rot, 62, 183
Sheep-laurel; *see* Mountain-laurel
Shell Chemical Corporation, 106
 D-D Soil Fumigant, 450
Shellac, 22, 24
Shellflower; *see* Tigerflower
Shepherdia, 361
Sherwin-Williams Company, 86, 87, 106, 419
Shooflyplant; *see* Apple-of-Peru
Shootingstar, 344
 leaf spot, 33, 344
 rust, 45, 345
Short-day plants, 27
Shortia, 228
 "Shot-gun" soil drench, 92
Shot-hole, 37, [38]
Shrub-althaea; *see* Rose-of-Sharon
Shrub-yellowroot, 188
 leaf spot, 33, 188
Shrubs, fertilizing, 19, [21]
 pruning, [21], [22]
 staking, 25-26
 watering, 27
 winter injury, 28-29
Sicana, 196; *see also* Cucurbit
 anthracnose, 37, 196
 seed treatment, 196

- Sida, 246
 leaf spot, 33, 246
 mosaic, 57, 247
 root-knot, 75, 247
 root rot, 73, 247
 rust, 45, 246
 southern blight, 62, 247
- Sidalcea, 246
 leaf spot, 33, 246
 mosaic, 57, 247
 root-knot, 75, 246
 rust, 45, 246
 southern blight, 62, 247
- Side dressing, 19
- Silene, 169; *see also* Carnation
 damping-off, 62, 169
 downy mildew, 41, 171
 flower or anther smut, 47, 171
 leaf spot, 33, 170
 root-knot, 75, 171
 root rot, 73, 169
 rust, 43, 169
- Silk-oak, 367
 dieback, gum disease, 64, 367
 root-knot, 75, 367
 root rot, 73, 367
- Silkgrass; *see* Yucca
- Silk-tassel-bush, 211
 black mildew, 48, 117, 213
 leaf spot, 33, 213
 root rot, 73, 117, 213
- Silk-tree; *see* "Mimosa" tree
- Silky sophora; *see* Sophora
- Silphium, 181
 downy mildew, 41, 185
 leaf spot, 33, 181
 powdery mildew, 43, 183
 root rot, 73, 183
 rust, 45, 184
 white smut, 50, 186
- Silver king; *see* Artemesia
- Silver lacevine, 367
 leaf spot, 33, 367
 rust, 45, 367
 smut, 48, 367
 tar spot, 33, 367
- Silver threads, 368
 bacterial soft rot, 68, 368
 leaf spot, 33, 368
 plant soak, 368, 429, 435
 root-knot, 75, 368
 root and stem rot, 62, 73, 368
- Silverbell; *see* Halesia
- Silverberry, 361; *see also* Russian-olive
 canker, dieback, 64, 285, 361
 leaf spot, 33, 361
 powdery mildew, 43, 361
 rust, 45, 361
- Sinningia, 109
- Sisalkraft paper, [29]
- Sisyrinchium, 254
- Skullcap, 362
 leaf spot, 33, 362
 powdery mildew, 43, 363
 root rot, 73, 231, 363
 stem rot (*Botrytis*), 38, 62, 208, 363
- Skyrocket; *see* Gilia
- Slide pump sprayer, [95]
- Slipperwort; *see* Calceolaria
- Smelowskia, 155; *see also* Cabbage
 rust, 45, 160
- "Smilax" of florists, 125; *see also* Asparagus
 fusarium wilt, 53, 125
- Smith, D. B., & Company, 106
- Smog, injury, 29
 prevention and correction of, 29
- Smokebush; *see* Sumac
- Smoketree, 380
 canker, dieback, 64, 380
 leaf spot, 33, 380
 mistletoe, 79, 381
 root nematode, 380
 root rot, 73, 117, 380
 rust, 45, 380
 verticillium wilt, 53, 380
- Smut, 10, 47, [49], 50
 anther, 47
 leaf, 47, 50
 seed, 47
 stem, 47
 white, [50]
- Snakeroot; *see* Aristolochia for Virginia snakeroot, Eupatorium for White snakeroot, Liatris for Button snakeroot
- Snapdragon, 368
 anthracnose, 37, 369
 canker, 64, 369
 crown gall, 68, 370
 crown rot, 62, 369
 damping-off, 62, 368, 369
 downy mildew, 41, 369
 flower blight, 70, 184, 368, 370
 fusarium wilt, 53, 369
 grav-mold blight, 38, 70, 368
 leaf blight, 37, 369, [370]
 leaf spot, 33, 369
 mosaic, 57, 369
 powdery mildew, 43, 369
 ringspot, 57, 370
 root-knot, 75, 369
 root nematode, 370
 root rot, 73, 369
 rust, 43, [44], 45, 368
 seed treatment, 369, 435
 soil drench, 369
 southern blight, 62, 369
 stem or collar rot, wilt, 53, 62, 369, [370]
 verticillium wilt, 53, 369, [370]
- Sneezeweed, 181
 aster yellows, 60, 183
 leaf smut, 50, 186
 leaf spot, 33, 181
 powdery mildew, 43, 183
 root rot, 73, 183
 rust, 45, 184
- Sneezewort; *see* Yarrow
- Snow blight, 334
 root nematode, 205, 207
- Snow injury, 30
- Snow - on - the - mountain; *see* Spurge
- Snowball, 404; *see also* Viburnum
 bacterial leaf spot, 33, 404
 canker, dieback, 64, 404, 405
 crown gall, 68, 117, 405
 downy mildew, 39, 404
 gray-mold blight, 37, 404
 leaf spot, 33, 404
- powdery mildew, 43, 404
 root-knot, 75, 323, 405
 root rot, 73, 117, 405
 spot anthracnose, 37, 404
 thread blight, 405, 409
 verticillium wilt, 53, 284, 404
- Snowbell, 367
 leaf spot, 33, 284, 367
 root-knot, 75, 323, 367
- Snowberry, 371
 anthracnose, 37, 73, 371
 berry rot, 38, 73, 371
 collar rot, 62, 211, 371
 crown gall, hairy root, 68, 372
 flower spot, 70, 371
 gray-mold blight, 37, 73, 372
 leaf spot, 33, 371
 powdery mildew, 43, 372
 pruning, 21
 root nematode, 372
 root rot, 73, 372
 rust, 44, 45, 371
 spot anthracnose or scab, 50, 73, 371
 stem gall, 372
 twig canker, 64, 371
- Snowdrop, 204; *see also* Daffodil
 botrytis blight, 38, 205
 bulb rot, 75, 204, 206
 bulb soak, 204, 429, 430, 434, 435
 smoulder, neck rot, 75, 206
 stem and bulb nematode, 61, 77, 207
- Snowdrop-tree; *see* Halesia
- Snowflake, 204
 bulb rot, 75, 204
 bulb soak, 428, 435
 leaf scorch or red blotch, 37, 205
 root nematode, 205, 207
- Snowberry, 372
 canker, dieback, 64, 372
 leaf blight, 37, 372
 leaf spot, 33, 372
 mistletoe, 79, 372
 mosaic, 57, 372
 powdery mildew, 43, 372
 root rot, 73, 117, 372
 thread blight, 372, 409
- Soapweed; *see* Yucca
- Sodium n-methylidithiocarbonate dihydrate, 443
- Soil, 15-18
 acid, 16
 acidifying, 16, 358
 alkaline, 16
 deficiencies, 17-18
 drainage, 25-27
 drench, 82, 92
 fill, preventing injury, 30, [31]
 fumigants, 439-44
 grade change, 30, [31], [32]
 liming, 16
 loosening, 16
 mixtures, 16
 pasteurization, 83, 437
 pH, 16
 sterilization, 83, 89, 437
 test, 17
 treatments, 437-44
 as virus carrier, 11
 waterlogged, 25

- Soil Drench C**, 459
Soil Fumigant M, 443
Soilfume 85, 442
Soilfume 40, 442
Soilfume 60–40, 442
Solanum, 389; *see also* Potato
Soluble salts, excess, 19
Sooty mold or blotch, 48, [49]
Sophora, 248
 broomong disease, 249
 canker, dieback, 64, 248
 damping-off, 62, 249, 333
 leaf spot, 33, 249, 286
 mistletoe, 79, 249
 powdery mildew, 43, 248
 root-knot, 75, 249, 323
 root rot, 73, 117, 248
 rust, 45, 249
 twig blight, 64, 248
Sorbus, 114
Sorreltree, 373
 dieback, 64, 373
 leaf spot, 33, 373
 purple blotch, 35, 373
 root rot, 73, 373
 twig blight, 64, 373
 wood rot, 64, 373
Sour gum, 211; *see also* Tupelo
 rust, 43, 213
 wood rot, 64, 142, 213
Sourwood; *see* Sorreltree
Southern blight, 62
Southern leatherwood, 153
 brown felt canker, 153, 241
 leaf spot, 33, 153
 rust, 45, 153
Spanish-bayonet; *see* *Yucca*
Spanish moss, 409
Sparaxis, 254
Spathoglottis, 302
Spearmint; *see* Mint
 Specimens, diagnosing, 5
 how and what to send, 5
 mailing, 5
Specularia, 140
Speedwell, 373
 aster yellows, 60, 374
 downy mildew, 41, 373
 fusarium root and stem rot, 53, 373
 leaf smut, 48, 50, 373
 leaf spot, 33, 373
 powdery mildew, 43, 373
 root-knot, 75, 374
 root nematode, 373
 root rot, 73, 231, 373
 rust, 45, 184, 374
 stem or crown rot, 62, 373
Spergion, 86, 419, 430
 Seed Protectant, 86, 419, 430
Spray Powder, 86, 419
 -SI Seed Protectant, 430
 Wettable, 86, 419
Sphaeralcea, 246
Spicebush, 127
 canker, 64, 127
 leaf spot, 33, 127
 mistletoe, 79, 128
 root rot, 73, 127
 sooty blotch, 48, 128
Spicelily; *see* *Manfreda*
Spicewood; *see* *Calycanthus*
Spiderflower, 374
 curly-top, 60, 374
 downy mildew, 41, 374
 leaf spot, 33, 181, 374
 root-knot, 75, 374
 rust, 44, 45, 184, 374
Spiderlily, 204
 leaf blotch or red spot, 37, 205
 leaf spot, 33, 207
 mosaic, 57, 205
 root nematode, 205, 207
Spiderwort; *see* *Tradescantia*, and *Rhoea* for Purpleleaf spiderwort
Spike-primrose, 228
 rust, 45, 228
Spinacea, 136
Spinach, 136; *see also* New Zealand spinach
 anthracnose, 37, 138
 bacterial soft rot, 68, 139
 black root rot, 73, 136
 boron deficiency, 17, 18, 137
 cercospora leaf spot, 33, 136
 chlorosis, 16, 139
 crown rot, wilt, 62, 64, 137
 curly-top, 60, 136
 damping-off, 62, 136
 downy mildew, [40], 41, 138
 fertilizing, 19
 fusarium wilt or yellows, 53, 137
 heart rot, 17, 137
 leaf, white smut, 50, 139
 leaf spot, 33, 136, 138
 mosaic, blight, 57, 137
 premature flowering, 28
 ringspot, 58, 139
 root-knot, cyst nematode, 75, 138
 root nematode, 139
 root rot, 73, 136
 rust, 43, 44, 45, 138
 scab, 50, 138
 seed rot, 136
 seed treatment, 136, 138, 428, 432
 spotted wilt, 58, 139
 verticillium wilt, 53, 139
 watery soft rot, 62, 138
 white-rust, [46], 47, 138
 yellow dwarf, 60, 139
 yellows, blight, 60, 137
Spinach beet, 136
Spindle-tree, 143
Spiraea, 374
Spirea, 374
 chlorosis, 16, 285, 374
 crown gall, hairy root, 68, 117, 374
 fire blight, 66, 114, 374
 leaf spot, 33, 374
 light requirements of, 27
 powdery mildew, 43, 374
 pruning, 21
 root-knot, 75, 374
 root nematode, 374
 root rot, 73, 374
 seedling blight, 62
Spores, fungus, 9, [10]
Spot anthracnose, 33
Spotrete, 459
Spotted wilt, 57, [58]
Spray Cop, 88
 Sprayers, 92–99
 accessories, 92
 barrel, 95
 cart, 95
 clogging of nozzles, 93
 compressed air, [93], [94]
 decontamination of, 93
 garden hose, 95, [98]
 household, [93]
 knapsack, [95]
 maintenance of, 100
 nozzle type, 91
 power, [98], [99]
 slide pump, [95]
 tractor boom, operating chart, 445
 trombone, 95, [96]
 wheelbarrow, 95, [97]
 Spraying, advantages and disadvantages, 92
 application to row crops, 444
 compatibility chart, 446
 coverage, 91
 equipment, 92–100
 fruits, 423–25
 materials needed for fruit trees, 426
 measuring apparatus, 90
 multipurpose mixes, 91, 423–25
 nozzles, 91
 orchards, 426
 precautions, 89–90, 423, 425
 preparation of mixes, 420–22
 tips, 90–91, 423, 425
 vs. dusting, 92
 Spreaders, trade names, 104
 uses, 104
Sprenger asparagus, 125; *see also* Asparagus
 crown gall, 68, 125
Spring glory; *see* *Forsythia*
Spruce, 330
 brown felt blight, 334
 canker, dieback, 64, 331
 cytospora canker, 64, 331
 damping-off, 62, 333
 gray-mold blight, 38, 333
 mistletoe, dwarf, 79, 333
 needle cast, 37, 330
 root nematode, 323, 333
 root rot, 73, 117, 333
 rust, needle, cone, 45, [332]
 witches'-broom, 45, 333
 seed treatment, 333
 seedling blight, 62, 333
 snow blight, 38, 334
 sunscorch, wind damage, 28, 334
 tar spot, 33, 330
 twig blight, 64, 330, 331
 wood rot, 64, 142, 330
Spurge (Euphorbia), 335; *see also* Poinsettia, and *see also* Pachysandra for Allegany, Japanese and Mountain spurge
 gray-mold blight, 37, 63, 336
 leaf spot, 33, 336
 powdery mildew, 43, 336
 root rot, 73, 335
 rust, 45, 184, 336
 soil drench, 335
 stem smut, 48

- verticillium wilt, 53, 335
 Spurge laurel; *see Daphne*
 Squash, 196; *see also Cucurbit*
 angular leaf spot, 35, 197
 anthracnose, 37, 73, 196
 aster yellows, 60, 200
 bacterial soft rot, 68, 200
 bacterial spot, 35, 197, 201
 bacterial wilt, 55, 197
 blossom blight, 70, 201
 blossom-end rot, 201, 390
 boron deficiency, 17, 201
 curly-top, 60, 199
 damping-off, 62, 200
 downy mildew, 41, 199
 fruit spot or rot, 68, 73, 172, 200
 fusarium wilt, 53, 198
 gray-mold rot, 38, 200
 gummy stem blight, 64, 200
 leaf blight, 37, 197
 leaf spot, 33, 197
 mosaic, 57, 199
 powdery mildew, 43, [198], 199
 ringspot, 58, 200
 root-knot, 75, 200
 root rot, 73, 132, 200
 scab, 50, 73, 197
 seed treatment, 196, 427, 431
 southern blight, 62, 200
 stem or crown rot, 62, 64, 200
 storage rot, 70, 200
 verticillium wilt, 53, 200
 Squaw-apple, rust, 43
 Squill, 399; *see also Hyacinth*
 bulb nematode, 78, 401
 bulb rot, 75, 400
 bulb treatment, 429, 430, 435
 crown and stem rot, 62, 400, 402
 flower smut, 47, 402
 mosaic, 57, 401
 Squirrelcorn, 144
 downy mildew, 41, 145
 rust, 43, 144
 Stachys, 362
 leaf spot, 33, 362
 powdery mildew, 43, 363
 root-knot, 75, 362
 rust, 45, 362
 Staggerbush; *see Lyonia*
 Stalk rot, 62
 Stanhopea, 302
 Stanleya, 155; *see also Desert-plume*
 leaf spot, 33, 158
 rust, 45, 160
 Staphylea, 112
 Star-of-Bethlehem, 399; *see also Tulip*
 leaf spot, 33, 402
 mosaic, 57, 401
 southern blight, 62, 402
 Star cactus; *see Cactus, Echinocactus*
 Star hyacinth; *see Squill*
 Starfire, 109
 Starglory; *see Cypressvine*
 Starry campion; *see Silene*
 Starter solution, 19
 Statice, 365; *see also Sea-lavender*
 aster yellows, 60, 365
 crown rot, 62, 156, 365
 flower blight, 70, 365
 gray-mold blight, 38, 365
 rust, 45, 365
 Stauffer Chemical Company, 85, 86, 87, 88, 106, 419
 D-D Soil Fumigant, 450
 Streptomycin, 89
 Zineb, 87, 419
 Steam disinfection of soil, 437-39
 methods, 437-39
 aboveground pipe, 439
 flash-flame pasteurizers, 439
 inverted pan, 439
 oven, 437
 pressure cooker, 438
 tank or vault, 438
 underground pipe, 438
 underground tile, 438
 precautions, 437-39
 pressure, 437-39
 temperature, 437-39
 time, 437-39
 waiting period, 437
 Stem blight, 62, 63
 canker, [63]
 diseases, 62-70
 nematode, 12, 60, [61]
 rot, 10, [62], 67
 rust, 43
 smut, 50
 Stenanthium, 399; *see also Hyacinth*
 rust, 45, 402
 Stenolobium, 399
 root rot, 73, 117, 399
 rust, 43, 399
 Stenotaphrum, 265
 Stephanomeria, 181
 leaf spot, 33, 181
 rust, 45, 184
 Sterilizing, soil, 83, 89, 437-39
 methods, 437-41
 chemicals, 439-44
 heat, 437-39
 precautions, 437
 wounds, 22-24
 Sternbergia; *see Fall-daffodil*
 Sterox, 104
 Stevia; *see Piqueria*
 Stickers, trade names, 104
 uses, 104
 Stillingia, 173
 Stock, 155; *see also Cabbage*
 anthracnose, 37, 156
 black rot, 35, 156
 clubroot, 75, 156
 curly-top, 60, [159]
 damping-off, 62, 155, 156, 157
 downy mildew, 41, 157
 fusarium wilt, 53, 155
 gray-mold blight, 38, 70, 158
 leaf spot, 33, 158
 mosaic, flower breaking, 57, [159]
 root-knot, 75, 134, 158
 root nematode, 160
 root rot, 73, 160
 seed treatment, 156, 429, 435
 spotted wilt, 58, 159
 stem or crown rot, 62, 64, 158
 verticillium wilt, 53, 160
 white-rust, 47, 158
 Stokes-aster, 181
 head blight (*Botrytis*), 37, 38, 70, 185
 leaf spot, 33, 181
 mosaic, 57, 184
 Stokesia, 181
 Stonecress; *see Candytuft*
 Stonecrop; *see Sedum*
 Stonemint; *see Dittany*
 Storage rot, 70
 Storksbill; *see Geranium* of florists
 Strangleweed, 80
 Stranvaesia, 114; *see also Apple*
 fire blight, 66, 114
 root rot, 73, 117
 Straw, 16
 Strawberry, 375
 angular leaf spot (bacterial), 33
 anthracnose, 37, 379
 aster yellows or green petal, 60, 378
 bacterial soft rot, 68, 73
 black root rot, [74], 375
 black-seed, 73, 377
 blossom blight, 70, 377
 bud rot, 378
 bulb and stem nematode, 61, 379
 cauliflower disease, leafy gall, 67, 379
 chlorosis, 16, 17, 379
 crinkle, 57, 378
 crown rot, 62, 377
 curly-dwarf, 60, 378
 downy mildew, 41, 380
 dwarf, crimp, [61], 379
 fire blight, 66, 114, 380
 fruit dip, 377
 fruit rot, 37, 73, 377
 gray-mold rot, blossom blight, 38, 70, 377
 leaf blight, 37, 377
 leaf and bud nematode, [61], 379
 leaf curl, 378
 leaf roll, 378
 leaf scorch, 37, 377
 leaf spot, [34], 377
 leaf variegation (genetic), 378
 mosaic, 57, 378
 mottle, 57, 378
 multiplier, 378
 plant dip, 377, 378, 429, 436
 powdery mildew, 43, 377
 red stele, 73, 376
 root-knot, 75, 378
 root nematode, 378
 root rot, 73, 375, 376
 slime mold, 378, [379]
 soil insect control, 376
 southern blight, 62, 377
 spray schedule, 424-25
Strawberry Diseases, 380
 stunt, 378
 Terraclor drench, 378
 veinbanding, 378
 verticillium wilt, 53, 376
 winter injury, 28, 376
 witches'-broom, 378
 yellow-edge, 378
 yellows (virus), 378
 zineb soil treatment, 376

- Strawberry-bush, 143
 Strawberry-tree, 145; *see also*
Arbutus
 crown gall, 68, 146
 Strawflower, 181
 aster yellows, 60, 183
 curly dwarf, 60, 184
 curly-top, [60], 184
 ringspot, 58, 184
 root-knot, 75, 134, 185
 stem rot, 62, 183
 verticillium wilt, 53, 141, 184
 Streak, 55
Strelitzia, 143
Streptanthera, 254
 mosaic, 57, 255
Streptomycin, disease control,
 35, 66, 322, 341
 formulations, 89, 422
 preparing solutions, 422
 trade names and distributors,
 88
 uses, 89
Streptomycin Spray, 89
Striga, 194
Striped squill; *see Tulip*
Stunt (virus), 58, [59]
Styrax, 367
Sugar beet; *see Beet*
Sugarberry, 241; *see also* Hack-
 berry
 downy mildew, 41, 241
 felt fungus, 63, 241
 leaf blight, 37, 241, 284
 leaf spot, 33, 241, 286
 mistletoe, 80, 241
 powdery mildew, 41, 241
 root rot, 73, 117, 241
 seedling blight, 62, 333
 thread blight, 241, 409
 witches'-broom, 241, [242]
 wood rot, 64, 142, 241
- Sulfur**
 deficiency, 17
 dioxide injury, 29
 as fungicide
 formulations, 88
 gallon lots, 422
 injury, 30, 88
 in multipurpose mixes, 91
 spray or dust, 47, 50
 uses, 88
- Sumac**, 380
 canker, dieback, 64, 118, 285,
 380
 crown gall, 68
 fusarium wilt, 53, 380
 inflorescence blight, 70
 leaf curl or blister, 47, 142,
 316, 380
 leaf spot or mold, 33, 380
 powdery mildew, 43, 380
 root nematode, 380
 root rot, 73, 117, 380
 rust, 45, 380
 "umbrella disease," 64, 380
 verticillium wilt, 53, 380
 wood rot, 64, 142, 380
- Summer-cypress*, 136; *see also*
Kochia
virus yellows, 60, 137
- Summer-hyacinth*, 399; *see also*
Hyacinth
- bulb nematode, 78, 401
 mosaic, 57, 401
Summer-lilac; *see Butterflybush*
Sundrops; *see Evening-primrose*
Sunflower, 181; *see Heliopsis*
 for Orange sunflower
 aster yellows, 60, 183
 bacterial leaf spot, blight, 35,
 186
 bacterial wilt, 55, 184
 crown gall, 68, 186
 curly dwarf, 60, 184
 damping-off, seed rot, 62, 183
 downy mildew, 41, 185
 gray-mold blight, bud rot, 38,
 185
 leaf gall nematode, 61, 185
 leaf smut, 50, 186
 leaf spot, 33, 181
 mosaic, 57, 184
 powdery mildew, 43, 183
 ringspot, 58, 184
 root-knot, 75, 134, 185
 root rot, 73, 183
 rust, 43, 45, 184
 seed treatment, 183
 southern blight, 62, 183
 stem or crown rot, 62, 183
 verticillium wilt, 53, 141, 184
 white-rust, 47, 186
 white smut, 50, 186
- Sunox*, 456
Sunrose, 381
 leaf spot, 33, 381
 root rot, 73, 381
Sunscaud, fruits and vegetables,
 27
Sunscorch, 28, 119
Sunshine shrub; *see St.-Johns-*
wort
Superintendent of Documents,
 25
Swamp-privet, 124
Swampbay, 127; *see also* Avocado
 black mildew, 50, 128
Swan River daisy, 181
 aster yellows, 60, 183
Swede; *see Rutabaga*
Sweet alyssum, 155; *see also*
Alyssum, *Cabbage*
 aster yellows, 60, 160
 black ringspot, 58, 159
 blackleg, 64, 155
 clubroot, 75, 156
 crown rot, 62, 64, 158
 damping-off, 62, 155, 156
 downy mildew, 41, 157
 mosaic, flower breaking, 57,
 159
 powdery mildew, 43, 160
 root-knot, 75, 134, 158
 root rot, 73, 160
 white-rust, 47, 158
Sweet corn; *see Corn*
Sweet-jarvil, 175
 damping-off, seed rot, 62, 176
 leaf spot, 33, 175
 rust, 45, 177
 seed treatment, 176
Sweet marjoram; *see Salvia*
Sweet-pepperbush; *see Clethra*
Sweet scabious; *see Scabiosa*
- Sweet sultan**; *see Centaurea*
Sweet-william, 169; *see also*
Carnation
 anther smut, 48, 171
 anthracnose, 37, 170
 aster yellows, 60, 170
 curly-top, 60, 170
 fusarium wilt, 53, 169
 leaf spot, 33, 169, 170
 leaf and stem nematode, 61,
 171
 mosaic, 57, 170
 ringspot, 58, 170
 root-knot, 75, 171
 root rot, 73, 169
 rust, 45, 169
 southern blight, 62, 169
 stem rot, 62, 64, 169
Sweetbay; *see Magnolia*
Sweetfern, 381
 rust, 43, 45, 381
Sweetgale, 410
 leaf spot, 33, 410
 rust, 43, 45, 410
 twig blight, 64, 410
Sweetgum, 412
 bleeding necrosis, 285, 413
 canker, dieback, 64, 285, 413
 felt fungi, 241, 413
 leader dieback, blight, 64, 413
 leaf spot, 33, 412
 mistletoe, 80, 413
 root-knot, 75, 323, 413
 root nematode, 413
 root rot, 73, 117, 413
 thread blight, 409, 413
 twig canker, 64, 413
 wood rot, 64, 142, 413
Sweetolive; *see Osmanthus*
Sweetpea, 311
 anthracnose, 37, 314
 ascochyta blight, 37, 313
 bacterial leaf spot, 35, 312
 blossom blight, 70, 314
 bud drop, 17, 314
 crown gall, 68, 314
 damping-off, 62, 312
 downy mildew, 41, 313
 fasciation or leafy gall, [67]
 314
 fusarium wilt, root rot, 53,
 311
 gray-mold blight, 38, 70, 314
 leaf spot, 33, 314
 mosaic, flower breaking, 57,
 312, [313]
 mycosphaerella blight, 37, 313
 powdery mildew, 43, 312,
 [313]
 root-knot, 75, 314
 root nematode, 314
 root rot, 53, 73, 311, 312
 rust, 45, 314
 seed treatment, 312, 427, 435
 soil drench, 311
 southern blight, 62, 312
 spotted wilt, 58, 313
 stem or crown rot, 62, 64,
 312, 313
 verticillium wilt, 53, 314
Sweetpotato, 382
 bacterial soft rot, 68, 73, 382
 bacterial wilt, 55, 385

- black rot, [72], 73, 382
 boron deficiency, 137, 385
 bud rot, 385
 crown rot, 62, 247, 385
 curly-top, 60, 385
 damping-off, 62, 382, 383
 feathery mottle, 384
 fertilizing, 19
 foot or crown rot, die off, 62, 64, 383
 fusarium wilt or stem rot, 53, [382]
 gray-mold blight, bud rot, 38, 385
 internal cork, 383, [384]
 leaf blight, 37, 383
 leaf spot, 33, 383
 mottle-leaf or mosaic, 57, 384
 mottle necrosis, leak, 385
 rhizopus rot, 73, [382]
 root-knot, 75, 383
 root nematode, 78, 385
 root rot, 73, 385
 rust, 43, 45, 385
 scurf or soil stain, 73, 383
 seed or root treatment, 382, 383, 428, 430, 432
 slime mold, 267, 385
 soil rot or pox, 50, 73, 383
 sooty mold, 50, 385
 southern blight, 62, 247, 385
 stem nematode, 61, 78
 storage rot, 68, 73, [382]
 thread blight, 385, 409
 2,4-D injury, 237, 385
 verticillium wilt, 53, 385
 white-rust, 47, 383
 yellow dwarf, 384
- Sweetshrub; *see* Calycanthus
 Swiss chard, 136; *see also* Beet
 boron deficiency, 17, 137
 curly-top, 60, 136
 damping-off, 62, 136
 downy mildew, 41, 138
 heart rot, 17, 137
 leaf spot, 33, 136, 138
 mosaic, 57, 137
 ringspot, 58, 139
 root-knot, 75, 138
 root rot, 73, 138
 rust, 43, 45, 138
 scab, 50, 138
 seed rot, 136
 seed treatment, 136, 431
 southern blight, 62, 138
 virus yellows, 60, 137
 yellow net, 57, 137
- Swordbean, 131
 Sycamore, 385
 anthracnose, 37, 385, [386]
 canker, dieback, 64, 385, 387
 chlorosis, 16-18, 285, 407
 crown gall, 68, 386
 leaf blight, 37, 385
 leaf scorch, 28, 386
 leaf spot, 33, 386
 mistletoe, 80, 387
 powdery mildew, 43, 386
 root rot, 73, 117, 387
 sooty blotch, 50, 117, 387
 twig blight, 64, 385, 387
 wetwood or slime flux, 218, 387
- winter injury, 28, 219, 386
 wood rot, 64, 142, 386
- Symporicarpos, 371
 Symptoms of disease, 33-80
 Syngonium; *see* Nephthytis
 Synthyris, 368
 leaf spot, 33, 369
 rust, 45, 368
- Syringa, 275
- T
- Tabebuia, 399
 Tabernaemontana, 298
 Taeniaid, 114
 leaf spot, 33, 114
 rust, 45, 114
- Tag Fungicide, 89
- Tagetes, 181
- Tallowtree; *see* Chinese tallow-tree, 173
- Tamarack; *see* Larch
- Tamarisk, 387
 canker, 63, 387
 powdery mildew, 43, 143, 387
 root rot, 73, 117, 387
 twig blight, 63, 387
 wood rot, 64, 142, 387
- Tamarix, 387
- Tanacetum, 181
- Tanbark-oak, 295
 leaf blight, 37, 295
 leaf spot, 33, 295
 rust, 45, 297
 wood rot, 64, 142, 295
- Tangelo; *see* Citrus, Orange
- Tangerine; *see* Citrus, Orange
- Tansy, 181
 leaf spot, 33, 181
 powdery mildew, 43, 183
 root-knot, 75, 134, 185
 rust, 45, 184
- Tar spot, 33
- Tasselflower; *see* Emilia
- Tasseltree, 211
 leaf spot, 33, 213
 root rot, 73, 117, 213
 sooty mold, 50, 117, 213
- Taxodium, 330
- Taxus, 414
- Teaberry; *see* Checkerberry
- Tear gas, 442
- Teasel, 388
 downy mildew, 41, 388
 leaf spot, 33, 388
 leaf and stem nematode, 61, 388
 mosaic, 57, 388
 powdery mildew, 43, 388
 root rot, 73, 388
 southern blight, 62, 208, 388
 stem or crown rot, 62, 208, 388
- Tecomaria, 399
- Telone, 77, 301, 324, 378, 395, 442
- Tennessee Corporation, 106
- Tennessee "26" Copper Fungicide, 88
- Tepary bean; *see also* Bean, garden types
 curly-top, 60, 133
- powdery mildew, 43, 133
 root rot, 73, 132
 rust, 45, 132
 southern blight, 62, 132
- Terracap, 85, 156, 442
- Terraclor, formulations, 85
 gallon lots, 422
 "shot-gun" soil drench, 85, 92
 soil application, 63, 75, 82, 156, 183, 274, 354, 442
 trade names and distributors, 85
 in transplanting water, 75, 156
 uses, 85
- Terramycin, dip, 70, 322
 in combination with streptomycin, 89
- Tersan 75, 87, 419
 OM, 266, 267, 269, 270
- Tetrachloro-p-benzoquinone, 86, 419
- Tetragonia, 136
- Tetramethyl thiuram disulfide, 87, 419
- Teucrium, 362
- Texas bean; *see* Bean, garden types, Tepary bean
- Texas-bluebell; *see* Prairiegentian
- Texas root rot, 73
- Texas silver leaf, 388
 root rot, 73, 117, 388
 twig canker, 63, 388
- Thalictrum, 208
- Thanksgiving cactus; *see* Cactus, Epiphyllum
- Thermopsis, 311; *see also* Pea
 leaf spot, 33, 314
 powdery mildew, 43, 312
- Thimbleberry, 347; *see also* Blackberry, Raspberry
 canker, blight, 64, 348
 fruit rot, 38, 70, 349
 gray-mold blight, 38, 70, 349
 mosaic, 57, 348
 rust, 45, 349, 350
- Thimer, 89, 266, 267, 269, 270
- Thiram, gallon lots, 422
 lawn diseases, 87, 266-71
 multipurpose mixes, 87, 91, 419
 seed and bulb treatment, 63, 67, 82, 87, 419, 430
 smog prevention, 29
 soil application, 62, 63, 82, 85, 87, 92, 419, 442
 spray or dust, 39, 70, 87, 419
 trade names and distributors, 87, 419
 tree wound dressing, 386
 uses, 87
- Thiram 50 Dust, 87, 419
 75W, 430
 SF-75, 430
- Thistle, 181; *see also* Cnicus
 for Blessed thistle, and Plumed thistle, G lobethistle
 inflorescence smut, 48
 leaf spot, 33, 181
 powdery mildew, 43, 183

- Thistle (*continued*)
 root rot, 73, 183
 rust, 45, 184
 stem or crown rot, 62, 183
 white-rust, 47, 186
- Thompson-Hayward Chemical Company, 106
- Thrift; *see Armeria*
- Thrips, injury, 325
 as virus carriers, 11, 57, 58, 83
- Thuja, 259
- Thujopsis, 259
- Thunbergia, 188
- Thylate, 87, 317, 353, 377, 419
- Thyme, 362
 root rot, 73, 231, 363
- Thymus, 362
- Tiarella, 252
- Tickseed, 181; *see also Coreopsis*
 aster yellows, 60, 183
 curly-top, 60, 184
 powdery mildew, 43, 183
 rust, 45, 184
 scab, 50, 138, 186
 verticillium wilt, 53, 141, 184
- Tidytips, 181
 powdery mildew, 43, 183
 spotted wilt, 58, 184
- Tigerflower, 232; *see also Glad-iolus*
 bacterial scab, 35, 50, 234
 bulb nematode, 78, 235
 bulb (storage) rot, 75, 232
 mosaic, 57, 234
- Tigridia, 232
- Tile, agricultural drain, 26
- Tilia, 280
- Tithonia, 181
- TMTD; *see Thiram*
- Toadflax, 368
 anthracnose, 37, 369
 aster yellows, 60, 370
 downy mildew, 41, 369
 leaf spot, 33, 369
 leaf and stem nematode, 61, 370
 powdery mildew, 41, 369
 root-knot, 75, 369
 root rot, 73, 369
 rust, 45, 368
 seed treatment, 369
 soil drench, 369
 southern blight, 62, 369
 stem rot, 62, 369
 white smut, 50, 371
- Toadstools, 64
- Tobacco; *see Flowering tobacco*
- Tolmiea, 329
- Tomatillo; *see Groundcherry*
- Tomato, 389
 anthracnose, 37, [72], 390
 aster yellows, 60, 394
 bacterial canker, 35, 66, 73, 391, 392
 bacterial soft rot, 68, 73, 390, 391, [392]
 bacterial speck, 35, 73, 391
 bacterial spot, 35, 73, 391
 bacterial wilt, 55, 395
 black walnut injury, 397
 blossom blight, 70, 397
 blossom drop, 28
- blossom-end rot, [7], 73, 390
 bud drop, 17, 396
 calico, 57, 392
 chlorosis, 16–17, 396
 crease stem, 397
 crown gall, hairy root, 68, 397
 curly-top, 60, 394
 damping-off, 62, 395, 396
 double virus streak, 393
 downy mildew, 41, 396
 early blight (*Alternaria*), [36], 37, 73, 389
 fertilizing, 19
 fruit cracking, [391]
 fruit spot or rot, 68, [72], 73, 389, 390, 391, 396
 fusarium wilt, [52], 53, 394
 gray leaf spot, 33, 390
 gray-mold rot, 38, 73, 390
 internal browning, 57, 392
 late blight, 37, 389
 leaf mold, 390
 leaf roll, 397
 leaf spot, 33, 390
 leaf and stem nematode, 61, 328, 397
 light, effect on flowering, 27
 milk, virus control, 393
 mosaic, 57, 392
 oedema, 28, 140, 160, 397
 phytophthora blight, 37, 396
 powdery mildew, 43, 397
 psyllid yellows, 396
 puffing or "pops," 396
 purple top, 60, 394, 396
 ringspot complex, 58, 394
 root-knot, 75, [77], 395
 root nematode, 395
 root rot, 73, 396
 seed rot, 395
 seed treatment, 391–92, 428, 432
 seedbed treatment, 395
 septoria leaf spot, [34], 389
 southern blight, 62, 396
 spotted wilt, tip blight, [58], 393
 staking vines, 83
 stem or collar rot, 62, 64, 389, 395, 396
 streak, 392
 sunscald, [7], 28, 390
 2-4-4 injury, 237, 292
 verticillium wilt, 53, [54], 395
 web blight, 134, 397
 western yellow blight, 60, 394
 wildfire, 35, 391
 yellow net, 392
- Tomato eggplant; *see Jerusalem-cherry, Eggplant*
- Toothwort, 155; *see also Cabbage*
 downy mildew, 41, 157
 leaf spot, 33, 157
 rust, 45, 160
 white-rust, 47, 158
- Torch flower; *see also Chrysanthemum*
 root-knot, 75, 134, 185
- Torchilily; *see Redhot-pokerplant*
- Torenia, 368
 root-knot, 75, 369
- Toyon; *see Photinia*
- Trachelospermum, 298
- Trachymene, 175
- Tractor, boom sprayer operating chart, 445
 injury, 30
- Tradescantia, 398
 gray-mold leaf blight, 38, 398
 leaf spot, 33, 398
 root-knot, 75, 398
 root nematode, 398
 rust, 45, 398
- Tragopogon, 272
- Trailing-arbutus, 243
 leaf spot, 33, 243
 powdery mildew, 43, 243
 wilt, crown rot, 62, 243
- Trailing four-o'clock, 227
 downy mildew, 41, 227
 leaf spot, 33, 227
 root rot, 73, 227
 rust, 45, 227
 white-rust, 47, 227
- Transvaal daisy, 181
 gray-mold blight, 38, 185
 leaf spot, 33, 181
 powdery mildew, 43, 185
 root-knot, 75, 134, 185
 root rot, 73, 183
 stem or crown rot, 62, 183
 verticillium wilt, 53, 141, 184
- Treating potted plants, 429, 433–36
 seed, 427–36
 soil, 437–44
- Tree
 borer control, 119, 212, 316
 "butchery," [23]
Care of Damaged Shade Trees, 25
 fertilizing, 19, [20]
 guying, 25, [26]
 injury from changing soil grade, 30, [31], [32]
 paint, [23], [24], 25, 386
 pruning, [21–23]
Reducing Damage to Trees from Construction Damage, 32
 removal, 22
 staking, 25, [26]
Tree Bracing, 25
Tree Wounds, 25
 watering, 27
 winter injury, 28–29
 protection, [29]
 wound dressing, 25, 386
 treatment, 22, [23], [24], 212
- Tree cypress; *see Gilia*
- Tree-of-Heaven, 398
 black mildew, 50, 398
 canker, dieback, 64, 398
 leaf spot, 33, 286, 398
 root rot, 73, 117, 398
 twig blight, 64, 285, 398
 verticillium wilt, 53, 284, 398
 wood rot, 64, 142, 398
- Tree peony; *see Peony*
- Tree-tomato, 389; *see also Tomato*
 bacterial canker, 35, 391
 powdery mildew, 43, 397
- Treemallow; *see Lavatera*

Treepoppy, 338
 leaf smut, 50, 339
 Tri-Basic Copper Sulphate, 88
 Trichloro-compounds
 n-trichloromethylthiophthalimide, 88
 n-trichloromethylthiotetrahydrophthalimide, 86, 419
 Trichloronitromethane, 442
 Trichosanthes, 196
 Tricop, 88
 Trillium, 398
 leaf smut, 48, 398
 leaf spot, 33, 398
 rust, 45, 399
 stem rot, 62, 208, 398
 Triplet lily, 151
 Tritoma, 351
 Triton B-1956, 104
 Tritonia, 232
 corm rot, 75, 232
 leaf spot, blight, 37, 234
 mosaic, 57, 234
 southern blight, 62, 232
 yellows (*Fusarium*), 51, 232
 Trizone, 376
 Trollius, 112
 Trombone sprayer, 95, [96]
 Tropaeolum, 293
 Troutlily; *see* Erythronium
 Trumpetcreeper; *see* Trumpet-vine, Bignonia
 Trumpetflower, 141
 Trumpettree, 399
 rust, 45, 399
 Trumpetvine, 399
 leaf blight, 37, 399
 leaf spot, 33, 399
 mistletoe, 80, 399
 powdery mildew, 43, 399
 root rot, 73, 399
 verticillium wilt, 53, 399
 Trunk canker, 63
 Tsuga; *see* Hemlock
 Tuberc rot, 70
 Tuberose, 204
 bacterial soft rot, 68, 75, 204
 botrytis blight, flower spot, 37, 39, 70, 205
 leaf and stem spot, 33, 207
 root-knot, 75, 207
 root rot, 73, 204
 tuber, offset, or "seed" soak, 207, 429
 Tulip, 399
 anthracnose, 37, 402
 bacterial soft rot, 68, 75, 400
 blindness, 402
 bulb rot, 68, 75, [76], 400
 bulb soak, 401, 429, 430, 435
 bulb and stem nematode, 78, [401]
 chlorosis, 16, [400]
 fire, botrytis blight, 37, 39, 70, [71], 399, [400]
 flower spot, 70, 399, 402
 flower stalk collapse, loose bud, 402
 frost injury, 402
 mosaic, mottle-streaking, flower breaking, [56], 57, [400], 401
 Rembrandt, virus-infected, 11
 root rot, 73, 400

smut, 47, 402
 southern blight, 62, 402
 stem rot, 62, 402
 sunscald, 28, 402
 tobacco necrosis, 402
 "topple," calcium deficiency, 18
 winter injury, 28, 402
 Tulipa, 399
 Tuliptree, 283
 canker, 64, 283
 leaf spot, 33, 283
 leaf yellowing or scorch, 283
 lightning injury (yellow-poplar), 32
 powdery mildew, 43, 283
 root nematode, 283
 root rot, 73, 117, 283
 seedling blight, 62, 283, 333
 sooty mold, 50, 283
 tar spot, 33, 283
 verticillium wilt, 53, 283, 284
 wood rot, 64, 142, 283
 Tuna; *see* Cactus, Opuntia
 Tupelo, 211
 canker, branch and trunk, 64, 211, 213
 felt fungus, 213, 241
 leaf spot, 33, 213
 mistletoe, 80, 213
 rust, 45, 213
 thread blight, 36, 213, 409
 verticillium wilt, 53, 213, 284
 wood rot, 64, 142, 213
 Turf specialist, 1, 3
 Turfing daisy; *see* Matricaria
 Turnip, 154; *see also* Cabbage
 anthracnose, 37, 157
 bacterial soft rot, 68, 73, 157
 bacterial spot, 35, 158
 blackleg, 64, 155
 boron deficiency, 17, 18, 158
 clubroot, 75, 156, [157]
 crown gall, 68, 125, 160
 curly-top, 60, 159
 damping-off, 62, 155, 156, 157
 downy mildew, 41, 157
 fertilizing, 19
 fusarium wilt or yellows, 53, 155
 gray-mold blight, 39, 158
 leaf spot, 33, 157
 mosaic, 57, 159
 powdery mildew, 43, 160
 ringspot, 58, 159
 root-knot, 75, 134, 158
 root nematode, 160
 root rot, 73, 157, 160
 scab, 50, 160
 seed treatment, 156, 428, 431
 southern blight, 62, 158
 storage rot, 73, 157, 158
 verticillium wilt, 53, 160
 watery soft rot, 73, 158
 web blight, 160
 white-rust, 47, 158
 Turquoise berry; *see* Ampelopsis
 Turtlehead, 368
 leaf spot, 33, 369
 powdery mildew, 43, 369
 rust, 44, 45, 368
 Tussilago, 181
 Tween-20, 104

Twig blight, 37
 canker, 63, [118]
 Twinflower; *see* Hyacinth-bean, Linnaea
 2,4,D injury, [7], 30
 using safely, 93
 2,4,5-T injury, 30

U

Udo, 108
 blight, 37, 108
 stem rot, 62, 108
 verticillium wilt, 53, 108
 UF-85, 299, 339
 Ulmus, 217
 Umbellaria, 127
 Umbrella-pine, 330
 damping-off, 62, 333
 leaf spot, 33, 330
 root rot, 73, 117, 333
 seed rot, 333
 seed treatment, 333
 soil drench, 333
 twig blight, 64, 330, 331
 Umbrellaplant, 403
 root-knot, 75, 403
 Umbrellawort, 227
 downy mildew, 41, 227
 leaf spot, 33, 227
 root rot, 73, 227
 white-rust, 47, 227
 Unicornplant; *see* Proboscis-flower
 Union Carbide Chemicals Company, Division Union Carbide Corporation, 89, 106
 Universal Metal Products Company, 93, 106
 Universities, land-grant, help by, 3
 listing of, 4-5
 Upjohn Company, The, 89, 106
 Uradice, 299, 339
 Urea-formaldehyde, 299, 339
 USDA, printed matter, 3, 25
 how to obtain, 3, 25
 U.S. Rubber Company, Naugatuck Chemical Division, 86, 87, 106, 419
 Uvularia, 277

V

Vaccinium, 145
 Valerian, 403
 leaf spot, 33, 403
 powdery mildew, 43, 403
 root rot, 73, 403
 rust, 45, 403
 stem rot, 62, 208, 403
 Valeriana, 403
 Valerianella, 403
 Vallotta, 204
 Vanda, 302
 hot water soak, 305, 429, 434
 Vanillaleaf, 129
 leaf spot, 33, 130
 Vapam, 70, 77, 89, 440, 443
 Variegation, infectious, 55
 Vascular tissue, or system, 51, 52, [54]

Vaughan Seed Company, 89,
106
VC-13 Nemacide, 73, 77, 444
Vegetables, fertilizing, 19
Vegetable grower, 1, 3
Vegetable-marrow, 196; *see also Cucurbita*
angular leaf spot, 33, 197
anthracnose, 37, 196
aster yellows, 60, 200
bacterial soft rot, 67, 200
bacterial wilt, 55, 197
blossom blight, 70, 201
curly-top, 60, 199
damping-off, seed rot, 62, 200
downy mildew, 39, 199
fruit spot or rot, 68, 70, 172,
200
fusarium wilt, 51, 198
gray-mold rot, 37, 200
gummy stem blight, 63, 200
leaf blight, 37, 197
leaf spot, 33, 197, 200
mosaic, 57, 199
powdery mildew, 41, 199
ringspot, 57, 200
root-knot, 75, 200
root rot, 73, 132, 200
seed treatment, 196
southern blight, 62, 200
stem, crown rot, 62, 200
verticillium wilt, 53, 200
Vegetable oyster; *see Salsify*
Vegetable sponge; *see Gourds*
Venus-lookingglass, 140
leaf spot, 33, 140
root rot, 73, 140
rust, 45, 141
seed smut, 48, 141
Verbascum, 368
Verbena, 263
bacterial wilt, 55, 263
downy mildew, 41, 263
flower blight (*Botrytis*), 38,
70, 263
leaf nematode, 61, 185, 263
mosaic, 57, 263
powdery mildew, 43, 263
root-knot, 75, 263
root rot, 73, 264
rust, 45, 263
spotted wilt, 58, 263
stem rot, 62, 231, 263
Verbesina, 181
Veronica, 373
Veronicastrum, 373
Versenol, 270, 285
Verticillium wilt, 53, [54]
Vervain; *see Verbena*
Vetch, 311; *see also Crown-vetch, Pea*
anthracnose, 35, 314
ascochyta blight, 35, 313
curly-top, 60
damping-off, 62, 312
downy mildew, 39, 313
fusarium wilt, 51, 311
leaf spot, 33, 314
mosaic, 55, 312
mycosphaerella blight, 35, 313
powdery mildew, 41, 312
root-knot, 75, 314
root rot, 73, 311, 312
rust, 43, 314
seed treatment, 312

soil drench, 311
southern blight, 62, 312
spotted wilt, 57, 313
stem rot, 62, 312, 313
Viburnum, 404
bacterial leaf spot, 35, 404
blossom blight, 39, 70, 404
chlorosis, 16, 285, 405
collar rot, 64, 211, 405
crown gall, 68, 117, 405
dieback, 64, 404, 405
downy mildew, 41, 404
gray-mold or shoot blight, 39,
70, 404
leaf spot or mold, 33, 404
light, requirements of, 27
powdery mildew, 43, 404
root-knot, 75, 323, 405
root nematode, 405
root rot, 73, 117, 405
rust, 43, 45, 405
spot anthracnose, 37, 404
stem canker or girdle, 64, 405
thread blight, 405, 409
twig canker, stem girdle, 64,
405
verticillium wilt, dieback, 53,
284, 404
wood rot, 64, 142, 405
Vicia, 311
Vidden D, 442
Vigna, 311
Vinca, 405
aster yellows, 60, 405
black ringspot, 58, 159, 405
canker, dieback, 64, 405
curly-top, 60, 405
flower breaking, 57, 405
gray-mold blight, 39, 405
leaf mold, 38, 405
leaf spot, 33, 405
mosaic, 57, 405
root-knot, 75, 405
root nematode, 405
root rot, 73, 405
rust, 45, 405
soil drench, 405
stem rot, blight, 62, 405
Viola, 309
Violet, 309; *see also Pansy*
anthracnose, 37, 309
crown, stem rot, 62, 68, 309
curly-top, 60, 310
downy mildew, 41, 309
flower blight, 70, 309
gray-mold blight, rot, 39, 70,
309
leaf nematode, 61, 310
leaf spot, 33, 309
mosaic, 57, 309
oedema, corky scab, 28, 309
plant soak, 310, 429, 435
powdery mildew, 43, 309
ringspot, 58, 310
root-knot, 75, 310
root nematode, 310
root rot, 73, 309
rust, 43, 45, 309
seed treatment, 309, 434
smut, 47, 48, 309
sooty mold, 50, 310
southern blight, 62, 309
spot anthracnose or scab, 50,
[308], 309

Virginia cowslip; *see Mertensia*
Virginia creeper, 237
canker, dieback, 64, 240
downy mildew, 41, 237
leaf spot, 33, 237, 240
powdery mildew, 43, 238
root rot, 73, 117, 239
spot anthracnose, leaf scab,
37, 239, 240
thread blight, 240, 409
Virginia snakeroot, 123
Virgins-bower, 188
Viruses, 10, 11
diseases caused by, 10
curly-top, 10, [60]
mosaics, 10, [56], 57
phloem necrosis of elm, 10,
218
ringspot, 10, 57, [58]
spotted wilt, 10, 57, [58]
stunt, 10, 58, [59]
yellows, 10, 58, [59]
spread of, 57, 83
Vitex, 263
Vitus, 237
Vocational agriculture teacher,
1
V. P. M. Soil Fumigant, 70, 77,
89, 440, 443

W

Wafer ash; *see Hopetree*
Wahoo, 143
Wall pepper; *see Sedum*
Wallcress; *see Rockcress*
Wallflower (*Cheiranthus*), 155;
see also Wallflower, western
aster yellows, 60, 160
bacterial rot, 33, 156
crown rot, 62, 158
gray-mold blight, 37, 39, 158
leaf spot, 33, 157
mosaic, flower breaking, 57,
159
white-rust, 47, 157
Wallflower, western (*Erysimum*), 155; *also includes Alpine and Siberian wallflower, see also Cabbage*
bacterial wilt, 55, 156
clubroot, 75, 156
downy mildew, 41, 157
leaf spot, 33, 157
powdery mildew, 43, 160
root rot, 73, 160
rust, 45, 160
spotted wilt, 58, 159
white-rust, 47, 158
Walnut, 406
anthracnose, 37, 406
bacterial blight, 33, [35], 408
boron deficiency, 17, 18, 409
branch wilt, 64, 408
bunch disease, 406
canker, dieback, 64, 407
collar rot, 211, 409
crown gall, 68, 407
downy spot, 41, 406
felt fungus, 241, 409
leaf scorch, sunscald, 28, 284,
409
leaf spot, 33, 406

- mistletoe, 80, 409
 "mouse ear," manganese deficiency, 17, 409
 nut mold, 73, 408
 powdery mildew, 43, 408
 root-knot, 75, 409
 root nematode, 408
 root rot, 73, 117, 408
 scab, 50, 406
 sooty mold, 48, 409
 thread blight, 409
 trunk canker, 64, 407
 verticillium wilt, 53
 wood rot, 64, 142, 408
 zinc deficiency, rosette, little leaf, 17, 407
- Wandering-jew; see Tradescantia*
- Wandflower*, 254
 mosaic, 57, 255
- Washingtonia*, 307
- Water-conducting tissue, 52, [54]
- Watering plants, 15, 28
- Watercress*, 155; *see also Cabbage*
 aster yellows, 58, 160
 clubroot, 73, 156
 damping-off, 62, 156
 downy mildew, 39, 157
 leaf spot, 33, 158
 mosaic, 57, 159
 root-knot, 75, 134, 158
 root rot, 73, 160
 rust, 45, 160
 white-rust, 47, 158
- Waterlily*, 409
 leaf spot, 33, 409
 leaf and stem rot, 37, 410
 white smut, 50, 409
- Watermelon*, 196; *see also Cucurbit*
 anthracnose, 37, 73, 196
 bacterial soft rot, 68, 73, 200
 bacterial spot, 35, 201
 bacterial wilt, 55, 197
 blossom-end rot, 73, 201
 cottony rot, 62, 200
 curly-top, 60, 199
 damping-off, 62, 198, 200
 downy mildew, 41, 199
 fruit spot or rot, 68, 73, 172, 198, 200
 fusarium wilt, [52], 53, 198
 gummy stem blight, 64, 200
 leaf spot, 33, 197, [198], 200
 mosaic, 57, 199
 powdery mildew, 43, 199
 ringspot, 58, 200
 root-knot, 75, [77], 200
 root nematode, 200
 root rot, 73, 132, 200
 scab, 50, 197
 seed rot, 200
 seed treatment, 196, 427, 431
 seedbed treatment, 200
 southern blight, 62, 200
 stem, crown rot, 62, 64, 200
 2,4-D injury, 201, 237
 verticillium wilt, 53, 200
- Watsonia*, 254
 mosaic, 57, 255
 root rot, 73, 254
- Waxberry*; *see Snowberry*
- Waxgourd*; *see Chinese waxgourd*
- Waxmyrtle*, 410
 black mildew, 50, 410
 leaf spot, 33, 410
 root nematode, 410
 root rot, 73, 410
 rust, 45, 410
 seedling blight, 62, 333, 410
 sooty mold, 50, 410
- Wayfaring-tree*; *see Viburnum*
- Weed specialist*, extension, 80, 83
- Weedkiller*, injury, 30
 contamination of sprayer, 90, 93
- Weigela*, 371
 crown gall, 68, 372
 leaf spot, 33, 371
 powdery mildew, 43, 372
 root-knot, 75, 323, 372
 root nematode, 372
 root rot, 73, 372
 twig blight, 64, 371
- Welsh poppy*; *see Meconopsis*
- West Indian gherkin*, 196; *see also Cucurbit*
 angular leaf spot, 35, 197
 bacterial wilt, 55, 197
 curly-top, 60, 199
 downy mildew, 41, 199
 leaf blight, 37, 197
 mosaic, 57, 199
 powdery mildew, 43, 199
 scab, 50, 197
 seed treatment, 196, 431
- Westbrook Manufacturing Company*, 106
- Westcott, Dr. Cynthia*, 1, 32
- Western yellow blight*, 60
- Wetting agents*, trade names, 104
 uses, 104
- Wheatgrass*, 265; *see also Bluegrass*
 anthracnose, 37, 265
 bacterial spot, blight, 33
 foot rot, 62, 265
 leaf blotch, scald, 37, 265
 leaf spot, 33, 265
 mosaic, 57, 271
 powdery mildew, 43, 266
 root nematode, 269
 root rot, 73, 267
 rust, 45, 266
 seed rot, 271
 seed treatment, 271
 seedling blight, 62, 271
 smut, 48, 270
 snow mold, 268, 269
 stem or culm rot, 62, 265
 tar spot, 33, 265
- Wheelbarrow sprayer*, 95, [97]
- White-alder*; *see Clethra*
- White beamtree*; *see Mountain-ash*
- White blister*, 47
- White cedar*; *see Chamaecyparis*
- White kerria*; *see Jetbead*
- White-rust*, [46], 47
- White smut*, [50]
- White snakeroot*; *see Eupatorium*
- Whitebrush*; *see Lemon-verbena*
- Whitecup*; *see Tomato*
- Whiteflies*, as bacteria carriers, 232
 secreting "honeydew," 48
 as virus carriers, 83
- Whitlowgrass*, 155; *see also Cabbage*
 downy mildew, 41, 157
 rust, 45, 160
 white-rust, 47, 158
- Wicopy*; *see Leatherwood*
- Wild-hyacinth*; *see Squill*
- Wild olive*; *see Osmanthus*, Olive
- Wild-sweet-william*; *see Phlox*
- Wild tuberose*; *see Manfreda*
- Wildbergamot*; *see Monarda*
- Willow*, 411
 bleeding canker, 64, 135, 285, 412
 canker, dieback, 64, 411, 412
 chlorosis, 16, 285, 412
 crown gall, 68, 412
 cutting rot, 62, 412
 cytospora canker, 411
 felt fungus, 241, 412
 leaf blight, 37, 411
 leaf blister, 47, 142, 412
 leaf spot, 33, 411
 mistletoe, 80, 412
 powdery mildew, 43, 411
 root-knot, 75, 323, 412
 root nematode, 412
 root rot, 73, 412
 rust, 43, 44, 45, 411
 scab (gray, black), 50, 411
 sooty mold, 50, 281, 412
 spot anthracnose, 37, 411
 sunscald, 28, 119, 219, 412
 tar spot, 33, 411
 twig blight, 64, 411
 wetwood or slime flux, 218, 412
 winter injury, 28, 119, 219, 412
 wood or heart rot, 64, 142, 412
- Wilt*, 10, 50
 bacterial, or brown rot, 51, [55]
 fusarium, or yellows, 51, [52]
 spotted, 57, [58]
- verticillium*, 51, 53, [54]
- Wilt-Pruf*, 27, 29, 150, 414
- Wind injury*, 30
- Windflower*, 112
- Winged loosestrife*; *see Lythrum*
- Winter-daffodil*; *see Fall-daffodil*
- Winter injury, 28–29, [119]
- Winter melon*; *see Cucurbit*, Muskmelon
- Winter protection, [29]
- Winterberry*; *see Holly*
- Wintercherry*; *see Chinese lanternplant*
- Wintercreeper*, 143
- Wintergreen*; *see Checkerberry*
- Wire injury*, 32
- Wirelettuce*, 181
 leaf spot, 33, 181
 rust, 45, 184
- Wishbone flower*; *see Torenia*
- Wisteria*, 248
 canker, dieback, 64, 248
 crown gall, 68, 117, 249
 leaf spot, 33, 249, 286

Wisteria (*continued*)
 mosaic, 57, 249
 powdery mildew, 43, 248
 root-knot, 75, 249, 323
 root rot, 73, 117, 248
 wood or heart rot, 64, 142, 412
 248

Witch-hazel, 412
 crown gall, 68, 117, 413
 leaf spot, 33, 412
 powdery mildew, 43, 413
 wood rot, 64, 142, 413

Witches'-broom, 47, [48], 66,
 68, 79, 241, [242], 248, 249,
 333, 406

Witchweed, 194

Withe-rod; *see* Viburnum

Wolfberry, 371; *see also* Snow-
 berry, and *see* Matrimony-
 vine for Chinese wolfberry
 collar rot, 62, 211, 371
 leaf spot, 33, 371
 powdery mildew, 43, 372
 rust, 44, 45, 371
 twig blight, canker, 64, 371

Wood anemone, 112; *see also*
 Anemone

white smut, 50

Wood rot, [64], [74]

Wood shavings, 16

Wood Tox, 456

Woodbine; *see* Virginia-creeper,
 Honeysuckle

Woodnymph, rust, 43

Woodridge Mixture "21," 85,
 268

Woodslia, 223

Wood sorrel; *see* Oxalis

Woodwardia, 223

Woodwaxen, 151; *see also*
 Broom

dieback, 64, 151

powdery mildew, 43, 151

rust, 43, 151

Wormgrass; *see* Sedum

Wormwood; *see* Artemisia

Wound dressing, [23], [24], 25

Wound rot, 64

Wound treatment, trees, 22-24,
 [24], 25, 212

dressing or paint, [23], [24],
 25

shaping, 22-24, [24]

sterilizing, 22, 25

treating, 22-24, [24], 25

Woundwort; *see* Stachys

Wyethia, 181

leaf gall nematode, 61, 185

leaf spot, 33, 181

rust, 45, 184

X

Xanthorhiza, 188

Xanthosoma, 162

bacterial soft rot, 67, 162

leaf spot, 33, 163

powdery gray rot, 73, 162

root rot, 73, 162

Y

Yam, 413; *see also* Sweetpotato

anthracnose, 37, 413

crown rot, 62, 414

leaf blotch, 37, 413

leaf spot, 33, 413
 root-knot, 75, 414
 root nematode, 414
 southern blight, 62, 414
 storage rot, 73, 382, 414

Yardlongbean; *see* Asparagus-bean

Yarrow, 181
 crown gall, 68, 186
 powdery mildew, 41, 183
 root-knot, 75, 134, 185
 root rot, 73, 183
 rust, 43, 184
 stem rot, 62, 156, 183

Yaupon, 245; *see also* Holly

black mildew, 50, 245

leaf spot, tar spot, 33, 245

root rot, 73, 117, 245

sooty mold, 50, 245

Yautia, 162; *see also* Xanthosoma

powdery gray rot, 73, 162

Yellow adderstongue; *see* Erythronium

Yellow blight, western, 60

Yellow-cedar; *see* Chamaecyparis

Yellow-elder; *see* Stenolobium

Yellow ironweed, 181

leaf spot, 33, 181

powdery mildew, 43, 183

ringspot, 58, 184

rust, 45, 184

Yellow-jessamine, 153

black spot, 33, 153

leaf spot, 33, 153

root rot, 73, 117, 153

sooty mold, 48, 153

Yellow-poplar; *see* Tuliptree

Yellow star; *see* Sneezeweed

Yellowroot, 188

leaf spot, 33, 188

Yellows (*Fusarium*), 51, [52]

virus, 58, [59]

Yellowtuft; *see* Alyssum

Yellowwood, 248

canker, dieback, 64, 248

powdery mildew, 43, 248

verticillium wilt, 53, 249, 284

wood rot, 64, 142, 248

Yerba-buena, 362

rust, 45, 362

Yew, 414

brown felt blight, 334, 415

crown gall, 68, 117, 415

damping-off, seedling blight,
 62, 333

dieback, 64, 414

needle, leaf blight, 37, 415

pruning, 22

root nematode, 414

root rot, 73, 415

root weevil, control, 415

twig blight, 64, 260, 415

winter injury, 28, 414

wood and heart rot, 64, 142,
 415

Yucca, 415

crown gall, 68

flower blight, 70, 415

leaf blight, 37, 415

leaf spot or mold, 33, 415

root-knot, 75, 415

rust, 45, 415

stem rot, 62, 415

Z

Zantedeschia, 162

Zanthoxylum, 250

Zauschneria, 221

rust, 45, 221

Z-C Spray or Dust, 87, 419

Zea, 190

Zebrina; *see* Tradescantia

Zelkova; *see* Elm

Zephyranthes, 204

bulb rot, 75, 204

leaf scorch or red spot, 37,
 205

leaf spot, 33, 207

rust, 45, 207

Zephyrlily; *see* Zephyranthes

Zerlate Ziram Fungicide, 87, 419

Zinc chelates, 17

deficiency, 17, 407, 408

Zinc dimethyl dithiocarbamate,
 87, 419

Zinc ethylene bisdithiocarbamate,
 87, 419

Zineb, gallon lots, 422

as lawn fungicide, 89, 266,
 269, 419

in multipurpose mixes, 87, 91

smog prevention, 29

soil application, 62, 82, 87,
 266, 376, 419, 442

spray or dust, 33, 39, 41, 47,
 50, 66, 70, 87, 419

trade names and distributors,
 87, 419

uses, 87, 419

Zinnia, 181

aster yellows, 60, 183

bacterial wilt, 55, 184

blossom or head blight, rot,
 39, 70, 184

curlly dwarf, 60, 184

curlly-top, 60, 184

damping-off, seed rot, 62, 183

leaf blight (*Alternaria*), 37,
 181, [182]

leaf nematode, 61, 185

leaf spot, 33, 181

mosaic, 57, 184

powdery mildew, [42], 43, 183

ringspot, 58, 184

root-knot, 75, 134, 185

root nematode, 186

root rot, 73, 183

seed treatment, 183, 429, 435

southern blight, 62, 183

spotted wilt, 58, 184

stem canker, 39, 64, 185

stem rot, wilt, 53, 62, 183

Ziram

gallon lots, 422

soil drench, 62

spray or dust, 33, 50, 87, 419

trade names and distributors,
 87, 419

uses, 87, 419

Zoysia, Zoysiagrass, 265; *see*
also Bluegrass

brown patch, 37, 267

dollar spot, 37, 267

leaf spot, blotch, 33, 265

root nematode, 269

root rot, 73, 265

Zygocactus; *see* Cactus, Cereus

Zygopetalum, 302



Date Due

JY 1 5 '64	MAR 2 3 1978
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